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ILLINOIS TECHNOGRAPH

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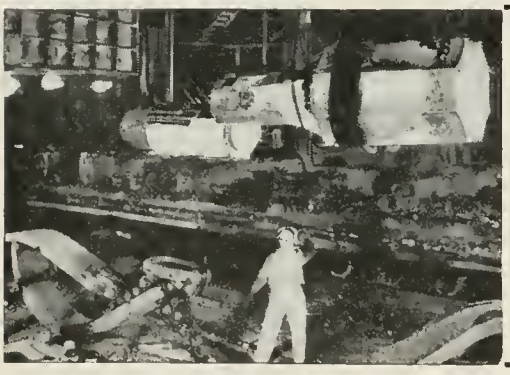

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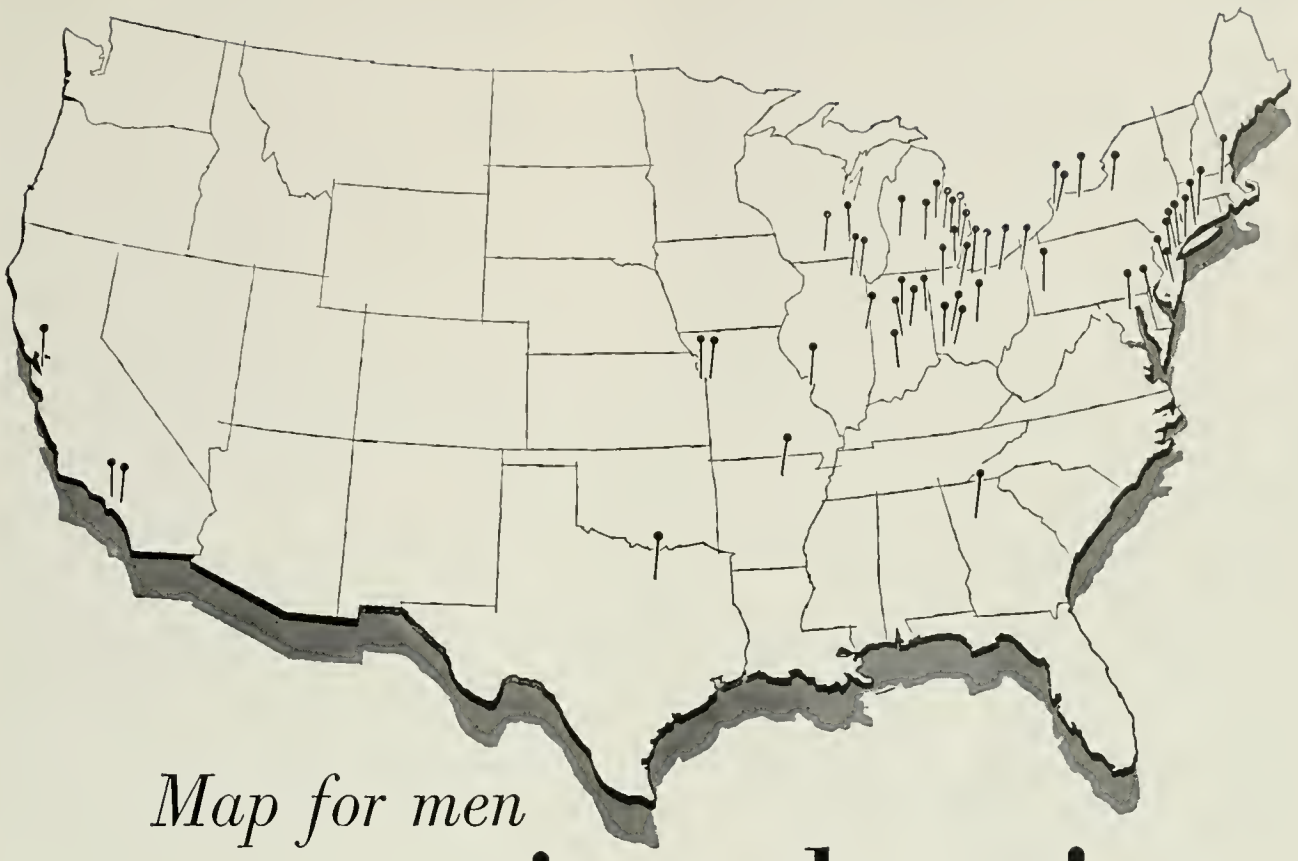

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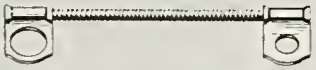
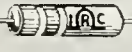


IRC Type AW Wire Wound Resistors



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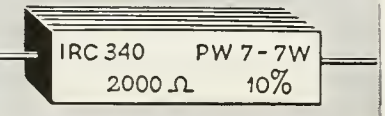

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Vice Versa —

Now that another term has started and old arguments are due to get their perennial renewal, this little story may be tossed around the field for what it's worth. It cost me eighty dollars.

When vacotion started this summer, I, like a true-blooded Illini, fastened my little brood around me and struck out for the hinterlands. Behind me, besides dusty books and momentarily interrupted "cherished memories," was a 9 cu. ft. refrigerator. This along with the other furnishings of my apartment, our summer tenants swore to care for "as their own." The old beast (the refrig) was grumpy, her oil seals were stiff, ond sometimes this caused her to forget to turn herself off. An annoying habit. Realizing this, we asked our tenant to call a repairman if the old gal put on a marathon. Our tenant, possessor of a Ph.D. (anthropalogy, I think) and a long forehead, swore compliance. One month later we learned old Bertha had run herself to death leaving a haspital bill af 80 Yankee dollars for a new motor. **Requiescat in Pace.**

Now the moral of this story may be never take summer tenants, but not altogether. The point is that the owner of that nobly prized possession, the Ph.D., would let a machine run night and day until he "smelled samething burning." And in all faith he was treating it as his own!

Saon the North side of the campus will be getting its usual barrage — what a bunch of nasty ole technicians we're making here and how we can't even quate Omar or discuss Spinoza. Granted there is a slight basis of truth here, but must we get "the word" from our southern neighbors who are in turn turning out students who have difficulty changing a washer on a leaky faucet? Tales have been going around lately that this is a world of machines. From the commerce student who has to sell them to the Home Ec gal who has to use them, ye olde LAS student is going to see a lot of machinery. Maybe a well-rounded education works both ways.

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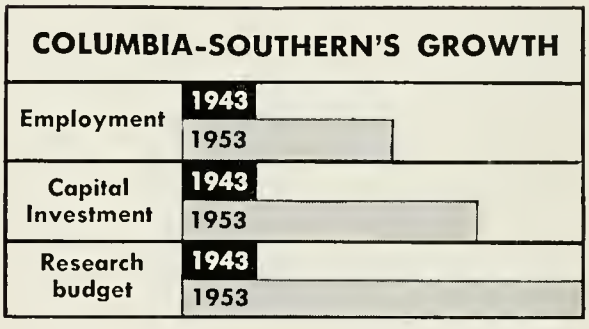

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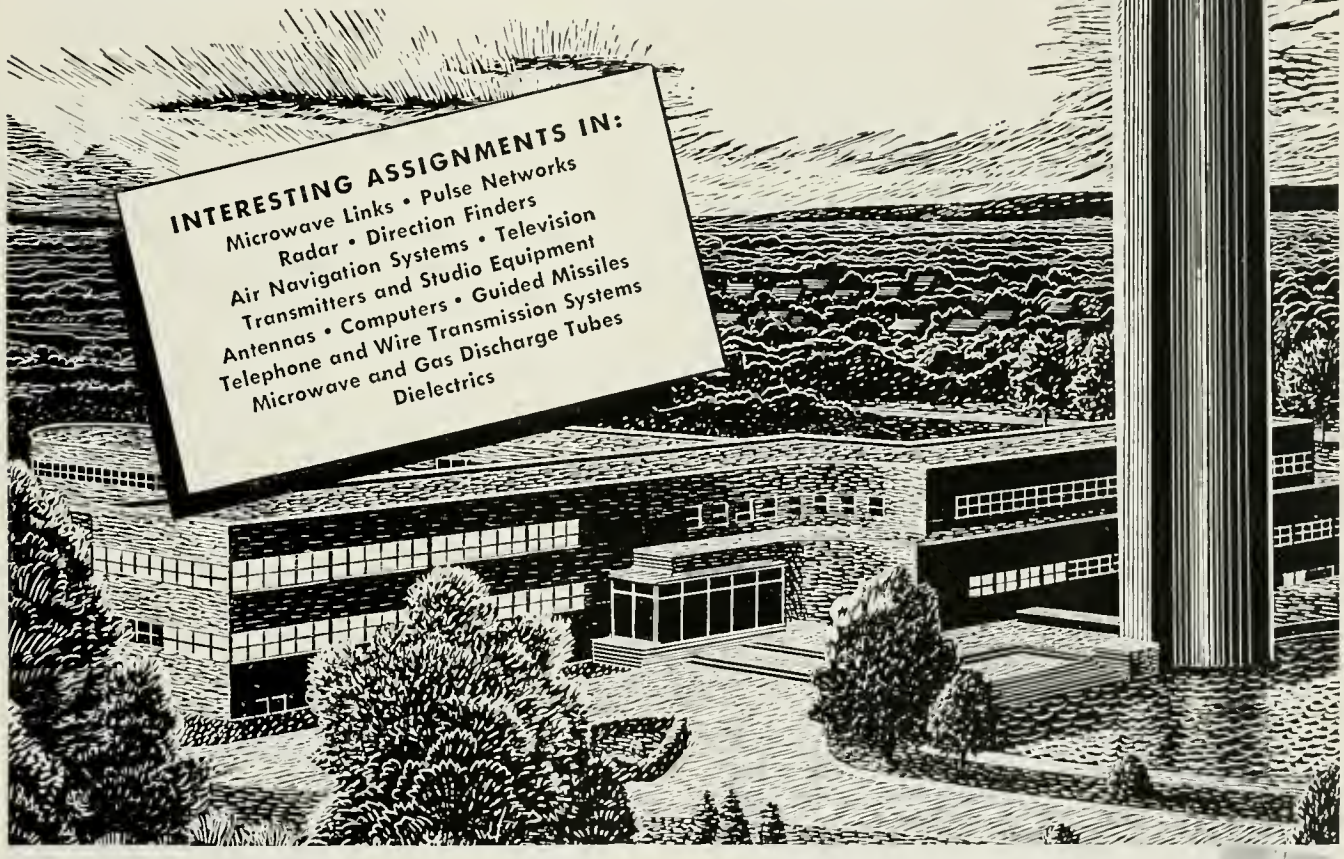

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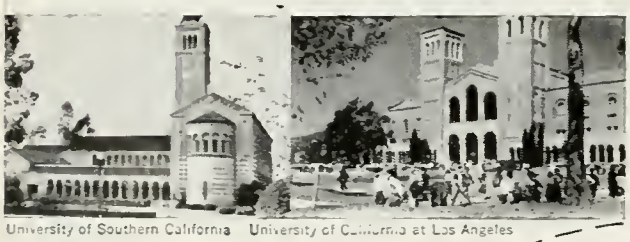

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THE ILLINOIS TECHNOGRAPH

volume 70 number 1

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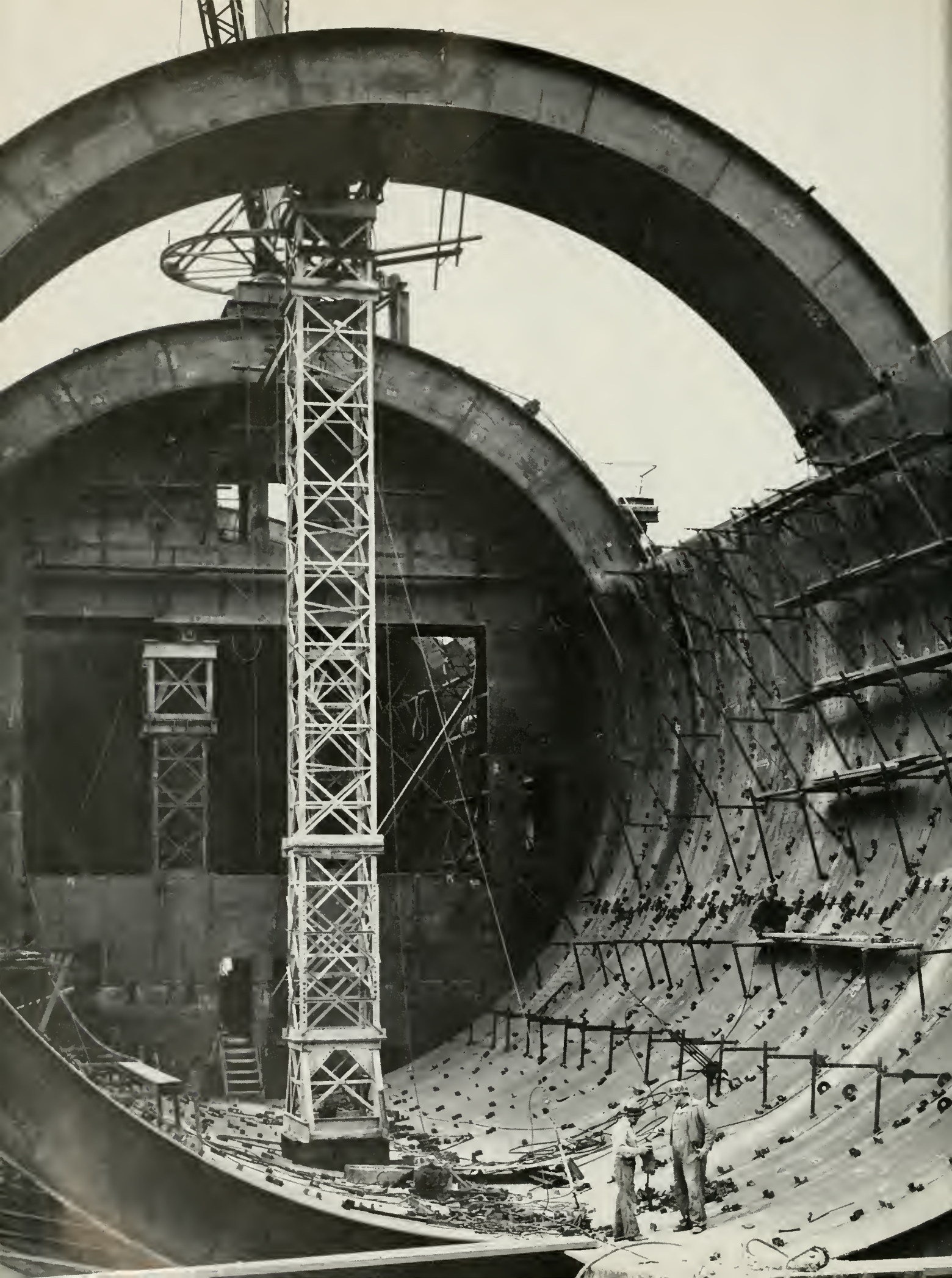
our cover

The Illini Union again welcomes freshmen and upperclassmen as well on their return to campus. Its beautiful Williamsburg architecture is the pride of the campus and it serves as the home of many student activities.

our frontispiece

Transonic circuit ducting of the world's largest tunnel. A test section 16 by 40 feet will be erected approximately where the "lattice-work" extends to the top and bottom. This tunnel will hold engines and their air frames at airspeeds at Mach 0.8 to Mach 1.2.



The Story of . . .

A. E. D. C.

by Paul E. LaViolette, E. E. '56

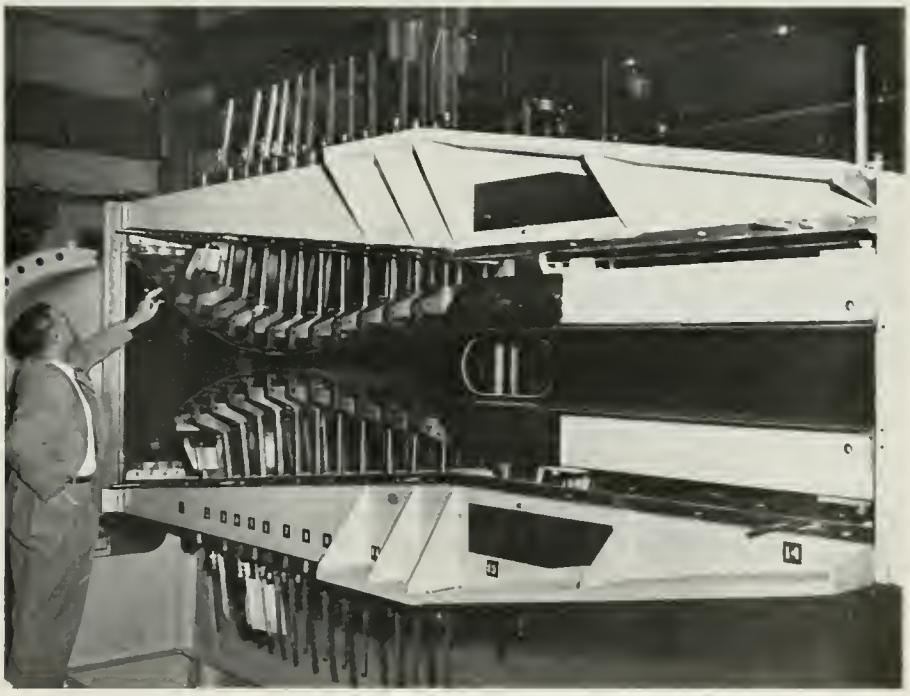
Sixty miles southeast of Nashville, in the "Barrens" of middle Tennessee, there is being built the greatest testing facilities for aviation in the world. The Arnold Engineering Development Center, when finished, will be able to give air frames and engines of future aircraft rigid examinations while simulating flight conditions of almost any altitude, climate, and speed.

The story of AEDC goes back to the end of the Second World War. It had become apparent at that time that German jet research was far in advance of that of the Allies. Earlier in the war the United States, in order to produce planes of quantity as well as quality, had made the critical decision to develop existing type-proven planes. This decision undoubtedly helped win the war, but with the consequence that fundamental aerodynamic research was critically stunted. In November, 1944, General H. H. "Hap" Arnold, then Commander of the Army Air Force, authorized Dr. Theodore von Karman "to investigate all the possibilities and desirabilities for postwar and future war's development as respects the Army Air Forces."

The results of Dr. von Karman's report indicated the need for a super air center, the ultimate cost of which would have been in the neighborhood of $536 million. Disagreement against spending this amount was strong. Although the report was submitted in February, 1947, it was not approved until May, 1948, and then with an appropriation of only $170 million. Construction for the appropriated center was to consist of an engine test facility, a gas dynamics facility, a propulsion wind tunnel and necessary suporting facilities. These, including a ram jet addition to the engine test facility, now comprise AEDC.

Although divided up into three sections, the prime idea of the center is to put plane and engine in windstreams and pressures with varying temperatures and velocities that will duplicate actual air flight. Most of this work is to be carried on in Mach numbers of 1 or greater.

Mach 1 — For an explanation of Mach numbers, perhaps it is best to start with the well known statement that Mach 1 is the speed of sound. This speed varies proportionately with the square root of the absolute temperature. (As the temperature of the air usually drops as altitude is increased, it is a common fallacy to confuse altitude, as is, as the cause of sound speed change.) At 60 degrees F, the normal temperature at sea level, Mach 1 is about 760 mph. The difficulty experienced at Mach 1 or faster speeds is due to the lack of air molecule preparation prior to the moving surface. Below Mach 1 a pressure wave advances before the surface causing the air molecules to move over, leaving room for the surface to enter the vacated area. At Mach 1 or better the air does not get this initial "brush off" and collides with the moving surface setting up a condition of shock. This shock is the basis of most sonic and supersonic troubles. Mass changes occur with resultant changes at the center of gravity. Drag increases and lift power decreases. And there are more seemingly endless complexities, e.g. flutter of control surface, weight change due to fuel consumption, and of course, landing. The aircraft has to reduce speed below Mach 1 in order to land, but now its wings, which were ideally suited for supersonic flight, provide insufficient lift for subsonic.



Tunnel of gas dynamics facility has a 12 by 12-inch test section. Does testing in the supersonic range on small-scale models of missiles and airframes.

The so called 'sound barrier" does not occur precisely at Mach 1 but varies from Mach 0.7 to 1.3. This speed range is commonly called the transonic region. Speeds from Mach 1 to 5 are called supersonic and those above Mach 5, hypersonic. Those below, naturally, are subsonic.

Reynolds Numbers — While Mach numbers cause difficulties to both actual flight in air and simulated flight in wind tunnels, another number, the Reynolds Number, gives trouble only in the wind tunnels. In the wind tunnel, instead of the obvious impracticality of using a full size B36, scale models are used. Models, however, if put in the same conditions as the actual plane, do not respond in the same manner, hence the Reynolds Number. The Reynolds Number is dimensionless and evaluates the ratio of the pressure force to the viscous forces for any flight condition. The ratio consists of:

air density $\times$ relative speed $\times$ length of the object $\div$ viscosity of the air

By applying this formula the difficulty encountered by the model may be overcome. Viscosity is dependent on heat (already determined by the Mach number desired) and can't be changed. Increased speed neecssitates larger horsepower motors. Changing the length of the model would defeat the initial purpose. Therefore, as air density is the only factor remaining, many air tunnels are pressurized. All the tunnels at AEDC are pressure tunnels.

Engine Test Facility—As mentioned previously, there are three test facilities at the center. Of these three ETF is the nearest to completion, being 95% constructed. Much of the equipment and design at ETF is German. An engine test facility was constructed in Germany during the war at Munich called the Bayerishe Motoren Werke (Bavarian Motor Works). It was completed in 1943 and run for a short period before the surrender. Thereafter it worked for a six month period testing British and American engines, before it was dismantled and sent to the States. The total value of the equipment was $10 million, but this does not include the invaluable knowledge and experience gained by the German attempt. Many of the German engineers came to America with the equipment, not only to work with ETF but in other facilities at AEDC as well. They have become indispensible to the success of the Center.

The original German plant was redesigned for higher altitudes and higher air capacity, and the original single test cell was increased to three and one test bed.

The plant is divided into three sections, the air side, test area, and exhaust side. Air side contains four four-stage 5,000 hp centrifugal compressors which go through a heat exchanger to a coole rdrier. The air is cooled down to minus 11° F in a series of steps, first using lake water, then chilled water, and trichlorethylene. From here it may be rerouted through heat exchangers to obtain exact heat.

The test area contains the three test cells and their control rooms. Each control room controls the engine inside its cell, whereas a master control room on the extreme end of the building controls the cells themselves. T.V. cameras monitor the engine in the cell to help prevent fire hazards and detect the start of any structural failures.

The cells themselves are installed in units so that the whole or part of the cell may be removed on small carts to help speed the installation of engines. The carts are mounted on rails and can be speedily transported to various sections of the facility.

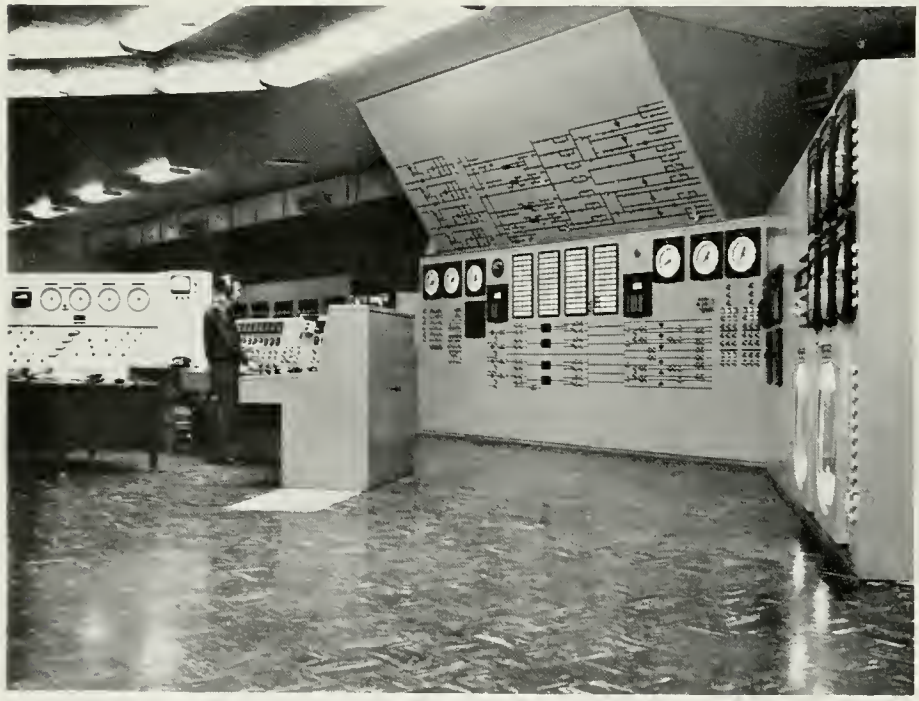
All test data will be processed by an ERA digital computer, that will enable a test crew to get final data within 30 seconds after the material is received. This is accomplished by direct connection of the test cells' data to the remote computer.

Ram Jet Addition—The RJA, while mechanically an dadministratively linked to ETF, is developing into the size of an independent facility. The Addition, still in the early stages of construction, consists of a test cell, two additional compressors, and two giant heaters. Air is to be obtained from ETF partially compressed. The RJA requires an additional 75,000 hp for its compressor and heaters besides the 20,000 hp that has been spent to compress the air at ETF. The return air is to be run through two 30,599 hp exhausters and then back through ETF's 40,000 hp exhausters.

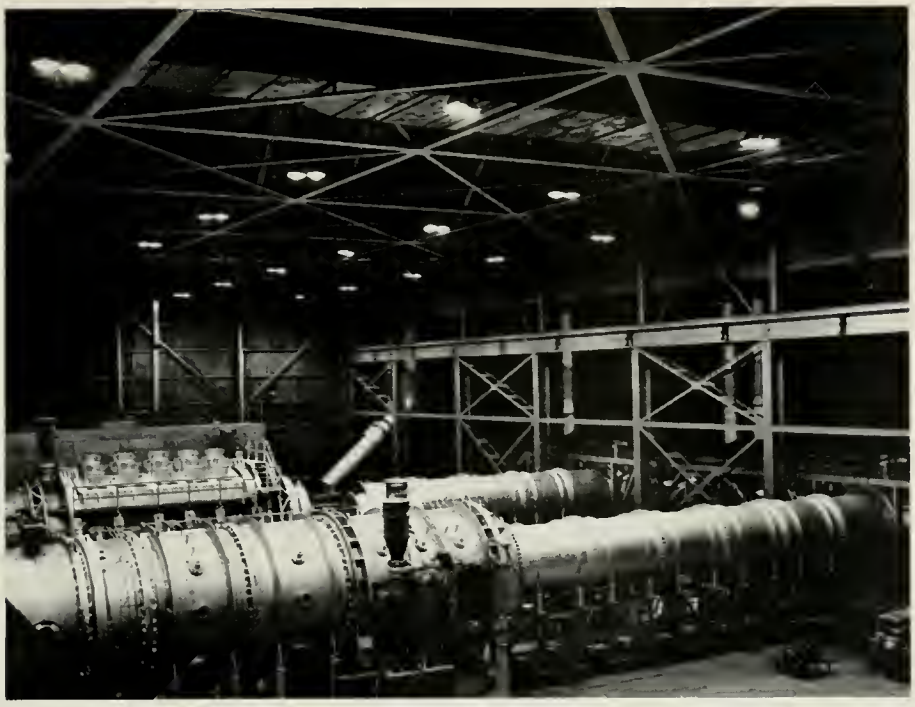
Two additional cells slightly larger than the present cells are planned. With new appropriations, it is hoped construction on these will be started as well.

Gas Dynamics Facility—At ETF our problems with the engine were well taken care of, but what of the airframe itself? As stated earlier, we want as high a Reynolds Number as can possibly be obtained, but imagine the size of the motors necessary to cause air flow of super and hypersonic proportions. To overcome the difficulty of a high Reynolds Number in a high Mach tunnel, an intermittant or "Blow-down" tunnel is used. This consists of a chamber filled with pressurized air of approximately 250 atmospheres connected to a test cell which in turn is connected to another chamber that has had its air evacuated. If two connected quick-opening valves are placed at the test cell end of the chambers we will have our desired high Reynolds and Mach numbers.

This idea, by the way, we also owe to the Germans. Design for tunnels of this type were found in Germany at the end of the war. California Institute of Technology undertook to do much research in this type tunnel, and the one cell at present in operation at GDF is a direct copy of a Cal Tech tunnel, but modified for higher Reynolds Numbers.



ETF main control room. Here the configuration of altitude, temperature and wind speed are determined for the various cells.



ETF test cells. In the foreground can be seen T-4. Ducting to the right is the upstream end leading into the compressor end of the building.

The uniqueness of the GDF tunnel lies in its two chambers. On the pressure side instead of having several bottles in tandem, one long 4 foot diameter bottle is used. "Long" in this instance is 720 feet, or about the length of two and a half football fields. The reason for the use of a single bottle is its possible later use as a shock tube. Needless to say, it will be the longest shock tube in the world, but at AEDC such adjectives are everyday occurrences. On the vacuum side the chamber is in the shape of a 72 foot diameter sphere which can be evacuated .1 atmospheres. The two together might represent GDF on a heraldic motif of AEDC in the form of a golf club and ball.

At present, as stated, there is only one tunnel in operation in GDF, E-1. E-1 is a 12 inch by 12 inch supersonic tunnel. There is planned another tunnel of similar size to E-1, which is to be a hypersonic tunnel. These two tunnels will be just starters as two larger 40 inch by 40 inch supersonic and hypersonic tunnels are planned. These giants at present just have their beds constructed and the first test work will not take place until early next year. These will differ from the smaller in that they will be of continuous flow instead of intermittant. The time of tests run with the bottle and sphere last but a few seconds to perhaps 15 minutes, whereas A & B will carry on continuous runs. This will be accomplished by large batteries of compressors and exhausters housed in a building that would do credit to a medium sized factory. Compressors in series stretch for an eighth of a mile, added to the "fans" or the test cell area reduced, the air speed will not go above Mach 1. All energy used in trying to overcome the speed of sound is used up in shock losses. In the supersonic region the situation is the reverse of the transonic region. Here the larger the test cell in ratio to the rest of the tunnel the greater the air speed above Mach 1. At GDF variable throat nozzles are put in the upstream section of the test cell; by varying the angle of opening into the cell, the Mach number can be controlled. Variable throat nozzle research is a big item at AEDC, not only for GDF with its hyper—and supersonic tunnels but at PWT with its transonic tunnel. Only through fine control at the throat openings can the Mach number be controlled.

Propulsion Wind Tunnel—The biggest thing at AEDC—which is a way of saying a giant among giants—is the Propulsion Wind Tunnel. This facility will consist of two large tunnels, one and are capable of pressure from 1 pound absolute to 2,500 pounds absolute.

Since time has been taken to go through the mysteries of Mach and Reynolds numbers, a few more words on another peculiarity of air traveling at sonic speeds in a wind tunnel might be of interest. In subsonic tunnels the test cell area is smaller than the rest of the tunnel. Air running from a larger to a smaller orifice, in this case the test area, increases in speed. Thus by either increasing the amount of air going through the larger portion of the tunnel or decreasing the cross section of the smaller, the speed of the air through the test cell may be increased. This is the situation up to Mach 1. Here the situation changes. No matter how much horsepower is transonic and the other supersonic. Together they form quite a collection of superlatives. For example:

Largest cross-sectional area of any tunnel in existence.

Electric motors will turn the world's

The GDF sphere may be exhausted to 0.1 atmospheres. In the foreground is the GDF trench.

largest rotating machinery. These will be assembled on the site. The roof is being removed to allow passage of some of the bigger parts.

Cooling water will be used at a rate comparable to that of a city the size of Washington, D. C., every day.

In order to minimize the problems encountered in the big transonic tunnel, a smaller tunnel, one sixteenth the size of the larger, has been built, and dubbed Pee Wee. The variable throat nozzles for the transonic tunnel designed to go through the tricky zone of Mach 0.9 to 1.6 have been proven in the smaller tunnel. Westinghouse contracted to build the rotary machinery for the tunnels, and has taken advantage of the smaller tunnel to insure success on the large machinery.

The name Propulsion Wind Tunnel was derived from the unusual fact that airframes tested will include their respective engines, attached and in full operation! So here are the efforts of both GDF and ETF combined so as to see the proven component parts work successfully as a unit.

ETF is not out of the picture yet, however. Since the air and exhaust demands of PWT are so great, the entire air and exhaust section of ETF are used. Therefore, to prevent interference with ETF, PWT will be run only at night. This turns out to be ideal as the power requirements (power is from TVA) are so large as to be scheduled for off-peak hours. To make another comparison, we might say that the annual power usage will about duplicate the yearly use of a city the size of Memphis, of 5 to 7 million kwh.

At the present only the transonic tunnel is under construction. Money for the supersonic tunnel has just been approved in the last Congressional appropriation. The supersonic tunnel is scheduled to have its "Pee Wee" too. The two tunnels will use the same set of drive motors. These motors will have a capacity of 216,000 horsepower.

The installation of the test units operates similiarly to an old time slide projector in the model assembly shop. The units are assembled in giant individual stalls on 300 ton, 40 foot test section carts. When ready the cart is mounted on a railway car (extra large) and rolled up to the tunnel. Here another unit having run through its paces is rolled out and the new "slide" is slipped in.

Auxiliaries—In order to supply the facility's gigantic thirst for water, a dam has been built across the Elk River and a 75-mile-shoreline reservoir made. The reservoir in combination with a small reservoir on the site can deliver 150,000 gpm. Besides cooling water for the site, the reservoir is a boon to the community, offering swimming, motorboating, and fishing along its miles of shoreline.

An airfield is planned with an 8,000 foot air strip and hangars. When constructed this will facilitate handling of test items and industrial personnel direct with the Center.

New Polymer

Rubbery parts with properties intermediate between those of silicone rubber and organic rubbers can now be produced by compounding with a new silicone polymer that can be vulcanized with sulfur and blended in any proportion with organic rubbers.

Identified as Dow Corning 410 Gum and available now in commercial quantities, this new polymer can be blended with or applied as a protective coating to extend the serviceable temperature limits and the weather resistance of organic rubbers. Brittle points in the range of —70°F and usefulness at temperatures up to 400°F can be realized by proper blending. The physical properties of the blend will fill between those of high strength silicone rubber and the organic rubber constituent.

Dow Corning 410 Gum can also be blended with oil resistant rubbers to increase their stability in contact with hot oil. Such blending also markedly improves the ozone and weather resistance of organic rubber.

Treated in an atmosphere created by an ozone generator, for example, a Buna N type rubber, compounded for test purposes, showed failure cracks in less than 30 minutes. Under the same conditions, a fifty-fifty blend of the same organic elastomer and Dow Corning 410 Gum, compounded with the same fillers and vulcanizer showed no cracks after more than 8 hours.

NEW BIBLIOGRAPHY

Listing a bibliography of 136 different reports on the subjects of bearings, lubricants and lubrication, The American Society of Mechanical Engineers, in its official publication Mechanical Engineering, published a digest of studies made during 1953.

The comprehensive summary was prepared by Dr. J. C. Geniesse and H. A. Hartung, with the assistance of the ASME Research Committee on Lubrication. Based on the Engineering Index references on bearings and lubrication, the digest correlates the various studies under specific subject groups to simplify reference to the bibliography.

Titled, "A Digest of 1953 Literature —Bearings, Lubricants and Lubrication," the summary appeared in the September issue of Mechanical Engineering.

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WHY STUDY MATH?

(Reprinted from General Electric Review)

Do you know what's going to become of you when you get out of high school?

If you don't, you'd better start thinking about it. Of course, maybe you *have* thought about it. Maybe you're planning to go to college. But if that's the case, it only changes the question a little: Do you know what's going to become of you when you get out of college?

By this time you're probably thinking: "So what?" The answer to that is this: No matter what you plan to do when you get out of high school or college, you're probably going to need more mathematics.

Yes, let's face it. Unless you're an exception, you need more math. No matter whether you plan to go on to college or not, no matter what you plan to do after college, chances are you won't have enough math. Many of the fellows and girls who went through school ahead of you found out they didn't have enough math. So they had to make it up to take the courses they wanted or to get the jobs they wanted.

It's a lot harder to catch up on mathematics later on. The time to think about it is now, while you're still in junior or senior high school. If you start early enough, math shouldn't be much trouble at all. Trouble is, the fellows and girls in high school don't realize how important it is to get a good groundwork in math. So we're going to try to explain it to you. First we're going to try to show you how important math is and why you're going to need it, no matter what you do after you finish school, and then we're going to try to show you that math isn't such a tough subject after all.

Why Math Is Important

Mathematics is going to be important to you no matter who you are or what you expect to become after school. Some people don't need much; they can get along with nothing more than arithmetic. Others need more math—maybe algebra, or geometry, or both. Still others need a lot of math—things like trigonometry or calculus. Let's take a few cases. Let's start at the top and work back; let's start with the people who need a lot of math.

The world today is pretty complicated. It's changed a lot in the past 40 years. Forty years ago there weren't very many scientists and engineers; the world was only just beginning to realize how important science and engineering are. The automobile was just getting started. Airplanes were a novelty. Radio and television hadn't been born yet. Most homes had no electricity; they got their light from oil or gas, they cooked on a wood, coal, or gas stove, they kept their food in an icebox, and they washed their clothes in a wash tub with a hand scrubbing board.

So they didn't need very many technical people in those days. Over a third of all the people who worked were unskilled; they needed very little education—they worked mostly with their muscles, not their brains. Today, although there are still more unskilled workers than any other occupation, *their total number has dropped from 13,400,000 to 11,500,000, while the total number of people working has increased from 37,300,000 to 55,800,000!*

Meanwhile the number of skilled and semiskilled workers went up over the same period. The skilled workers jumped from 4,364,000 to 7,632,000, and the semiskilled workers doubled, jumping from 5,500,000 to 11,000,000.

Back in 1910 there were only 60,000 engineers in the whole United States. Only one out of every 621 people working as an engineer. That wasn't very many. But by 1950 the number of engineers had increased to 400 000—one out of every 139 persons working was an engineer.

We Need Trained People

Yes, the world is pretty complicated today, compared to what it was 40 years ago. And it's getting more complicated all the time. This means that we have to have more and more specially trained people. [We need them not only to work out the really tough problems of science like learning how to harness the power locked up in the atom—we need them not only to produce the new and wonderful materials like plastics, to find new ways to conquer disease, to design the machines of industry and the labor-saving gadgets of the home—we need them more and more for the ordinary things of every day life.]

It takes special training nowadays to be a good carpenter, or a plumber, or an automobile mechanic. But those are simple compared to electronics. We used to think a radio serviceman had to have a pretty special kind of training, but it's much tougher for a TV serviceman today.

Right now some of you who read this are probably thinking: "That's all right for technical people, but I want to be an artist, a druggist, or a nurse," or "I want to go into business for myself. What on earth good will math do me?" All right, let's see.

Most artists today go in for what artists call *applied* art. They want to use their ability to draw and paint in advertising, or interior decorating, or something that will pay them good money. But the people in business who hire the artists for that kind of work say that simple artistic ability is not enough any more. There are lots of fellows and girls with artistic ability, but not enough of them know anything about physics, mechanical things, or mathematics.

To be a druggist you have to be a chemist. This means you have to study chemistry. And don't let anyone tell you that you can learn chemistry without knowing something about algebra.

How about a nurse? One of the required subjects in a course of nursing in a modern hospital is known as Materia Medica, and one of the things you'll learn in Materia Medica is how to figure out doses and solutions of medicines and the like. Algebra is important in doing the figuring. Too many nurses flunk out of the course nowadays because their math is weak.

It's the same thing with a trade. Whether you want to be a draftsman, a machinist, a molder, or a pattern-maker, you'll find out that you need algebra and geometry, plus other things like trigonometry.

Even if you want to go in business for yourself, you'll still need math. For business today, whether it's running the little gas station at the corner or the big factory down by the river, it takes good management and good management takes mathematics.

The most important of all needs for mathematics are the needs of those who are going to keep up the wonderful progress we're making these days in science and engineering. There's a great demand for such technically trained people. They're needed in the offices and factories that turn out the things we need in peacetime and develop new ones

for tomorrow. And our military forces need them, too—badly.

War Is Complicated

For war is a very complicated business, also. It isn't like the old days, when big armies met in battle and slugged it out hand-to-hand. Nowadays a war is fought with airplanes and battleships and tanks and radar and atom bombs. We fight our wars as much with machines as we do with men, and we need men with special training to run the machines. We need them to pilot the planes, to operate the radar, to control the gun turrets on bombers and battleships with such accuracy that even the rotation of the earth is sometimes taken into account.

The people who run our business and military affairs know how badly we need people with special technical training, and they're doing everything they can to persuade more people to get that training. For there just aren't enough trained people to go around. The jobs are there, waiting for them when they get out of high school or college, but not enough fellows and girls are studying the right things.

Trouble is, they don't start early enough. This means that, if you want to be an engineer or a scientist or almost anything at all these days out of the ordinary, you've got to start thinking of it now, while there's still a chance to study those subjects you need to start with. And the most important of these rock-bottom subjects is mathematics.

But the fellows and girls in high school aren't getting enough math. The United States Office of Education says that only 20 per cent of all high-school students are taking math. Why so few?

There are probably a number of reasons. Maybe you, like many others, don't think you're going to need math in the work you're going to do. And it's true that there are plenty of jobs open where you don't need anything but just plain arithmetic. An athlete, for example, or a farmhand, or a sales clerk, or the operator of a telephone switchboard. There's still a big need for people who are skilled with their hands or who have strong muscles.

What About Computers?

Maybe you've read about those wonderful computers or calculating machines that are being built today—machines that work by electronics to do all sorts of complicated problems in mathematics at terrific speeds. Maybe you think we should let those machines do our math problems. If you do, you haven't got the right story about the computers.

The point is that a computer is no better than the human mind that designed it or the human mind that runs it. It has to have a mathematician to run it. The only difference between the man and the computer is that the machine works faster. Somebody has to analyze the problem, "set it up," and feed it into the machine before the machine can solve it. (We'll tell you more about this business of analyzing later on.) Computers are a big help—but don't think we can leave it to machines to do all our math for us.

There's still another angle you shouldn't forget. True, you can get along these days without much more than simple arithmetic if you're not particularly ambitious, but there are lots of times that more math would be a big help to you in your everyday affairs.

A famous British mathematician says that we live surrounded by figures—cooking recipes, railway timetables, unemployment insurance, fines, taxes, war debts, schedules of working hours, speed limits, bowling averages, betting odds, calories, automobile and truck weights, temperatures, rainfall, hours of sunshine, miles per gallon, electricity and gas meter readings, bank interest, parcel post and freight rates, radio wavelengths, automobile and bicycle tire pressures, and many more. And we need to know how to use our figures. Let's take a very simple example.

Suppose you have to drive somebody to the station to catch a train. The station is two miles away, and you have four minutes to get there before the train leaves. You start out in the car, and you drive the first mile at 15 miles an hour. Then all of a sudden you realize you'd better speed it up if you want to make it. How fast do you have to drive that second mile in order to get there before the train leaves?

Don't spend too much time figuring it out, for there's a catch in it. No matter how fast you go, you can't make it. You used up your whole four minutes driving that first mile. But the point is that it takes algebra to solve a simple problem like this. Anybody who's had elementary algebra should know right away that he should drive faster than 15 miles an hour to make the train.

There are lots more cases in everyday life where simple arithmetic is not enough, and more math would be a great help. A little application of the principles of geometry, for example, would help you in parking the family car. If you play baseball and want to hit a home run, you might wonder which is more important, a heavier bat or hitting the ball harder. There's a mathematical formula in physics which tells you that it's more important to hit the ball harder.

When you get married and set up housekeeping, there will be lots of times when you could use a little more math to help you solve every day problems. You may want to figure out whether it's worth while to turn down the thermostat at night when you go to bed, so the furnace won't use so much fuel. But you'd probably have to use some advanced math like calculus in order to find out whether you'd really save fuel or not.

Who Sits Where?

Take a simple little thing like figuring out who sits where at a dinner party. You're going to have six people at the table. Believe it or not, there are 720 different seating arrangements for six people! Figuring out things like that is easy—if you have enough math.

Take the case of the fellow in Milwaukee not so long ago who was picked up by a motorcycle cop for speeding. The cop didn't check the speed on his speedometer; he was stationed at a street corner and he guessed the speed. They went before the judge in police court and the driver of the car got the cop to admit that the car had stopped for a traffic light just before the arrest was made. The driver then proved to the judge *by mathematics* that no car in existence could have picked up speed fast enough to be exceeding the speed limit where the cop was stationed. And the judge let him off.

But there's still one more reason why you should study more math now, while you still can get the ground-work. Even if you aren't going to need more than arithmetic in your job when you get out of school, even if you decide you can get along with just arithmetic in solving your everyday problems, you still may be the kind of person who needs to know something about advanced math to get the most out of life.

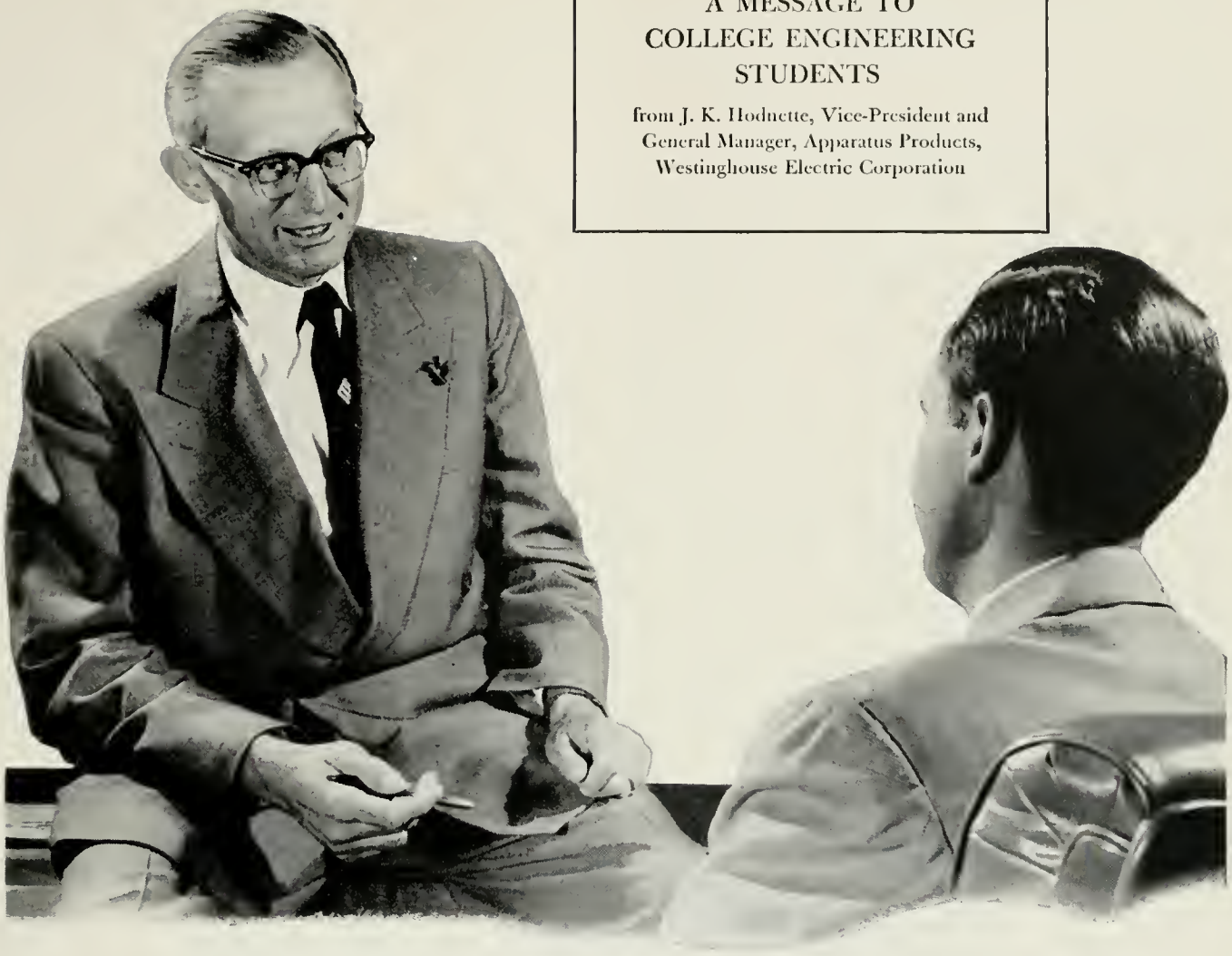
Now some people are satisfied to go on living from day to day, having a good time but not caring much about anything else. But there are lots of people who aren't content to live that kind of life. They're interested in life, and other people, and what makes the wheels go around—what makes it rain or snow, what the stars are, or what makes radio and TV work. Such people are just plain curious about things. They like to learn as much as they can, because they're interested in everything that goes on.

Trouble is, if you're that kind of person, you almost have to learn something about the more advanced branches of math if you want to understand the things you get curious about. Algebra and geometry are so important to an all-round education that it's hard to get through high school without taking those subjects. And many colleges make you study more than that just for a general all-round education.

If you want to learn something about astronomy and how it's possible to measure the distances to the sun or the

A MESSAGE TO
COLLEGE ENGINEERING
STUDENTS

from J. K. Hodnette, Vice-President and
General Manager, Apparatus Products,
Westinghouse Electric Corporation



To the young man with a vision of success

Success means different things to different men. It can mean professional recognition, or great achievement, or exciting work, or many other things. Whatever its special meaning to you—keep its image in your mind, for you are already well on the way to achieving it!

If you are *determined* to become a research scientist, you *can* be. If you have a burning ambition to become a sales engineer, you can be. If you have your sights set on a top executive spot, you'll be there someday. One might think a large company like Westinghouse would have more pressing things to think of than the ambitions of its young engineers. On the contrary, nothing is more important . . . for our professional people are our biggest asset.

Here at Westinghouse, intensive efforts are made to help our professional men realize their individual goals —through extensive training programs, study programs leading to advanced degrees, leadership programs, and guidance in professional development. You are treated as an individual at Westinghouse.

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moon or the stars, you've got to know something about trigonometry. If you want to understand the laws which govern the working of the universe which includes our earth, the sun, and all the stars, you have to understand the calculus.

Suppose you're interested in economics. That's the study of such things as inflation and banking, whether we're going to have enough food or gadgets or machines to go round, and what we're going to use for money. The fellows who study economics are great ones to use statistics, and in order to make their statistics easy to understand, they make graphs or curves of them. This comes under the subject of analytical geometry —a handy subject to know if you're interested in economics.

A Brick Problem

Before we finish thinking about the importance of knowing more mathematics than just simple arithmetic, let's take one more example of the use of math to solve a simple problem. The problem is the sort of thing that might come up in one way or another to bother anybody nowadays. Although it might be about anything from shoes to automobiles, let's use bricks for example. This is our brick problem:

A brick weighs 10 pounds plus a half a brick. How much do two bricks weigh?

Now actually there are three ways to solve that problem. The hardest way is the way a fellow would do it if he didn't know any more math thon simple arithmetic. We could call this the guessing method. By this method, you'd say that one brick must weight more than 10 pounds—perhaps 12 pounds. But we were told that a brick weighs 10 pounds plus a half a brick, and if one brick weighs twelve pounds, a half a brick weighs 6 pounds, and 10 pounds plus 6 pounds is 16 pounds, not 12.

So we try again. If we try 15 pounds next, we find it still doesn't work, for then 10 pounds plus a half a brick (7½ pounds) would be 17½ pounds. Not until we try 20 pounds do we find that it works, for then 10 pounds plus a half a brick equals 20 pounds. This makes two bricks weigh 40 pounds, which is the right answer.

An easier way to solve the problem is to do it with algebra. If we let x equal the weight of one brick, then we can set up a simple equation and solve it out like this:

$$\begin{aligned} x &= 10+\tfrac{1}{2}x \\ x-\tfrac{1}{2}x &= 10 \\ \tfrac{1}{2}x &= 10 \\ x &= 20 \\ 2x &= 40 \end{aligned}$$

In other words, two bricks weight 40 pounds, which is the same answer we got by the guessing method.

There's still a third way to do it. It's the easiest one of all. To anyone well grounded in math, particularly algebra, this problem is so simple that he sees the essentials right away; he can figure it out in his head. He may be unconsciously doing it by algebra, but if you were to ask him how he did it, chances are he wouldn't say he used algebra at all but just common sense or logic.

And that's the beautiful part of a good groundwork in math. It helps you to think things out logically. For mathematics is just an application of the principles of logic.

What Is Math, Anyway?

And this brings up a question that ought to be answered right now: What is mathematics, anyway? A lot of people have a completely wrong idea of math as something that's terribly hard to learn, something mysterious, something that only "brains" and geniuses can get good marks in. Well, if that's the way you feel about math, you're wrong.

When you came right down to it, all—or nearly all—of mathematics, no matter how advanced, no matter how strange it may seem, is just the four simple parts of arithmetic: addition, subtraction, multiplication, and division. The more advanced branches of mathematics teach you how to use these four parts of arithmetic to solve harder problems, and they teach you how to do those four things *fast*.

For we use the simple kinds of math as stepping stones to reach the more complicated kinds. Once we learn addition, subtraction, multiplication, and division, it's easy to learn algebra. Once we learn algebra, it's easy to learn geometry. Logarithms are just a kind of short cut to help solve problems in arithmetic. Algebra's another short cut.

Geometry, however, isn't really mathematics at all. It's the logical study of the shapes and sizes of things. We just use math in figuring out the measurements and capacities of geometrical figures—how big they are or how much you can put into them.

Trigonometry is the next stepping stone after geometry. It uses some of the things we learned in geometry as tool's for measuring distances. With trigonometry we can do surveying—or we can measure the distance from the earth to the moon, the sun, or even some of the stars. But when you solve a problem in trig, you still use arithmetic: addition, subtraction, multiplication and division.

The calculus is a very wonderful branch of math. While geometry and trigonometry are used to figure out problems about things that are standing still, so to speak, the calculus is used to solve problems about things that are always changing, like the speed of a bomb dropping out of an airplane. Yet the calculus is just a more elaborate method of using addition, subtraction, multiplication, and division.

One kind of math that often scares those who don's know much or anything about it is the use of formulas and symbols. They look strange to us, and because we don't know what they mean, they may scare us a little. But there's really nothing to be scared of, for such things are just a kind of shorthand which mathematicians, scientists, and engineers use. They use them as a simple way of writing complicated ideas or methods of solving problems.

Serve the Pi

Probably the best known of these is the Greek letter pi. If you've studied geometry, you know it's the number of times that the diameter of a circle can be divided into its circumference—about 3 1 7 times, roughly speaking. The actual figure is a very complicated number, for when you divide the circumference of a circle by its diameter it never comes out exactly; the answer keeps running on and on to more and more decimal places.* So, because it's impossible to write it down exactly, we use a symbol for it. Although this symbol, pi, has many other uses in mathematics, most people know, when they see it, that it means the number of times the diameter of a circle can be divided into its circumference.

It's the same way with other symbols. Every one of them is just a kind of shorthand for something longer and more complicated. When you get a mark of A— or maybe F—on an examination paper or your report card, it tells you how well yo udid. If it weren't for the symbol, somebody might have to write a lot of words like: "This is a very good paper." or "This student didn't pass."

That's the way it is with all the signs and symbols of math. Every one of them means something long or complicated, and it saves time and space to use the symbol.

Don't think that the mathematicians and engineers and scientists can understand all the symbols. Some of the signs, of course, like pi, are pretty well known. But many of them are used only by people in special kinds of work, and people in other kinds of work may not known any more about what the signs mean than you do.

Formulas are used in the same way. People who study physics have proved by experiments that, if you're trying to knock a home run, its more important to hit harder than it is to use a heavier bat. They've figured out just what difference it makes when you use something heavier to hit with, and how much

*Here's pi to ten places: 3.1415926535. Although mathematicians have figured out its value to over 1,000 decimal places, no more than ten decimal places are ever needed for the most precise work.

THE ALUMINUM INDUSTRY WAS BORN ON SMALLMAN STREET

▼ In 1888, the aluminum industry consisted of one company—located in an unimpressive little building on the east side of Pittsburgh. It was called The Pittsburgh Reduction Company. The men of this company had real engineering abilities and viewed the work to be done with an imagineering eye. But they were much more than that. They were pioneers . . . leaders . . . men of vision.

A lot has happened since 1888. The country . . . the company . . . and the industry have grown up. Ten new territories have become states, for one thing. The total industry now employs more than 1,000,000 people—and the little outfit on Smallman Street? Well, it's a lot bigger, too—and the name has been changed to Alcoa. ALUMINUM COMPANY OF AMERICA . . . but it's still the leader—still the place for engineering "firsts".

As you prepare to trade textbooks for a position in industry, consider the advantages of joining a dynamic company like Alcoa—for real job stability and pleasant working conditions—where good men move up fast through their association with the recognized leaders in the aluminum industry.

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difference it makes when you hit harder.

When you hit with something twice as heavy, it does twice as much good. But when you hit twice as hard, it does four times as much good. When you hit with something three times as heavy, it does three times as much good. But when you hit three times as hard, it does nine times as much good.

It wouldn't be easy to remember how much difference it makes, depending on whether you hit harder (increase the velocity, that is) or use something heavier, if it weren't for this simple little formula:

$$E = \frac{MV^2}{2}$$

The formula may look strange to you, but don't let it scare you just because of that. It's just a combination of signs arranged in the form of an equation in algebra. Each of the signs has a pretty simple meaning. If you know the meanings, you can read them just as you read a sentence in English.

Translated into English, that formula says:

Energy (E) equals half the product of the mass (M) times the square of the velocity (V).

You can translate it still more if you want to. But the point is, that compact little formula is a very quick and convenient way of saying a much more complicated thing. And if it weren't for algebra, we wouldn't be able to say it so quickly or so simply.

So it amounts to this: if you know what the signs mean, and you have studied algebra, you can understand what most of those strange formulas mean. And when you understand that, you'll realize all of a sudden that most of the strangeness of higher mathematics or subjects like physics, or chemistry, or electrical engineering, is caused by the strange symbols and formulas that are used. If you learn what the symbols and formulas mean, those things won't seem anywhere near so strange. You'll find they don't scare you anywhere near as much.

So Far, So Good

Now that we've gotten this far, let's stop a moment and get our bearings. If you've understood what's been said, you know these things:

1. The world today is complicated.
2. That means we need lots more people with special training.
3. That means we'll all need more math.
4. Mathematics can help us even if we don't need it in our jobs.
5. All math is based on simple arithmetic.
6. Most all math is just special ways of using arithmetic or of doing arithmetic fast.
7. Much of the strangeness of math is caused by the symbols and formulas, and they're just a convenient sign language.

Before we finish thinking about what math is and how we use it, let's think about one more thing that we learn when we learn math: analysis. When we have a problem, or something happens, and we have to figure out what to do, that's called analysis.

Your arithmetic, your algebra, your geometry, trigonometry, calculus, and other branches of math are the tools you use to solve problems. But you can't use the tools unless you analyze your problem first to see what you've got, what you need to do, and how you should do it. Analysis tells you which tools to use, and how to use them, in solving your problem.

Analysis is the most important part of mathematics. Anybody can learn to use the tools, but unless he learns analysis, he'll never be able to solve problems, even the simplest ones.

If we want to know what per cent 48 is of 60, it's analysis that tells us to divide 48 by 60 to get the answer (80%). In solving that problem of the brick that weighed 10 pounds plus a half a brick, it was analysis which made us decide whether to use the guessing method or algebra. And if we were really good at analysis, we solved it while we were analyzing it.

For that's where analysis gets particularly worth while—when we have such a good grounding in math that we learn to be really sharp in analyzing our problems. And when you remember that analysis is just intelligent, logical thinking, why then you'll begin to see one of the most important things about learning a lot of math. That is: the more math you get, the better you'll be able to think.

Professor Bailey of the University of Michigan said something about that in an article he wrote not long ago. He said that education is mainly along three lines: (1) learning facts; (2) learning to get along with other people; and (3) learning to think better. The first two are not very hard—even a dog can do them. A dog, for example, learns such facts as where his home is, who his master is, and when he gets fed. He also learns to get along with people—if he's had any training, that is.

Can a Dog Think?

But when it comes to the job of learning to think better, that's too much to expect of a dog. Many people believe that a dog can't even think in the first place—that thinking is something that's done only by human beings. All human beings think, but some do a lot more of it, or do it better, than others.

Professor Bailey wondered what it was that made some people think better than others. He said the first thing necessary to be a thinker was to be born that way, like Benjamin Franklin or Thomas A. Edison. *They* didn't have to be taught to think.

But that doesn't mean people can't be taught to think—or think better. Professor Bailey gave the names of some great examples of well-educated people—Elihu Thomson, Steinmetz, Langmuir, Coolidge. Their education, far from interfering with their ability to think must have been a great help to their thinking ability.

Then Professor Bailey asks what studies in school help most to develop the habit of thinking. And the first of these, he says, is arithmetic. In the study of arithmetic the student is made to think logically and accurately— probably for the first time! And its pretty well agreed that the more math you get, the more logically you think.

So it's to your advantage to study as much math as you can, while you still have the chance. And the best time to get a good groundwork in math is while you're still in junior and senior high school. You'll find it much easier to get through college if you get a good grounding in math now. It will help you to get a better job afterwards, too. Most important of all, it will help you to think better and to get the most out of life.

Will You Choose One of These Occupations for a Career?

These occupations need lots of math:

Architect, Aeronautical Engineer, Agricultural Engineer, Astronomer, Ceramic Engineer, Chemical Engineer, Chemist, Civil Engineer.

Electrical Engineer, Geologist, Marine Engineer, Mechanical Engineer, Metallurgist, Mining Engineer, Petroleum Engineer, Physicist.

Pulp & Paper Engineer, Research Scientist, Sanitary Engineer, Surveyor, Textile Engineer.

These occupations need quite a lot of math:

Accountant, Airplant Pilot, Artist, Auditor, Carpenter, Dentist, Dietician, Doctor, Draftsman, Electrician, Housewife, Machinist, Mechanic, Merchant.

Molder, Musician, Nurse, Painter, Plumber, Statesman, Stonemason, Teacher, Writer.

These occupations need arithmetic only:

Athlete, Athletic Coach, Baseball Player, Farmer, Fireman, Football Player, Gas Station Attendant.

Photographer, Policeman, Sales Clerk, Soda Clerk, Stenographer, Telephone Operator.

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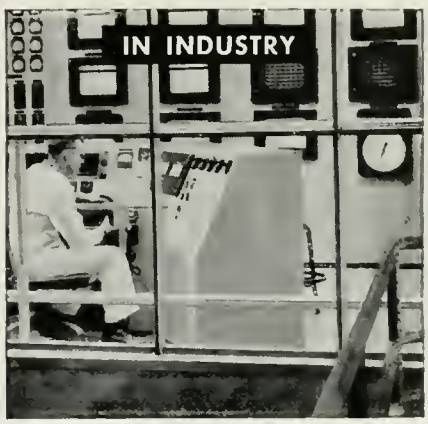

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Book Review . . .

One, Two, Three—Infinity

George Gamow
Viking Press $4.75

(Reviewed by Paul E. LaVictatte, E. E. '55)

"'The time has come,' the Walrus said, 'to talk of many things . . . of atoms, stars and nebulae, of entropy and genes; and whether one can bend space and why the rocket shrinks.'" With this as a preface, Gamow starts off perhaps his most far ranging and certainly his most popular book. Gamow has written this book for the layman, and in doing so encounters some difficulty, for he tries to guide his reader through the bogey-land of science much like a scoutmaster leading a group of young cub scouts. Sometimes he remembers his readers are cubs and other times he treats them as eagles. Of course his context is a formidable one and the difficulty of explaining even half of the above subjects in simple language has lain waste scores of educators.

If "One, Two, Three—Infinity" is taken for what it was meant to be, an introductory idea to a wide variety of scientific subjects and ideas, the reader is in for some exciting reading. He journeys the staggering road from microcosmos to macrocosmos, finds infinity in his hand, and loses himself in the space inside an atom. He is introduced to speculations on the beginning and ending of the universe and made to stand like an Atlas in space to view the galaxy spread before him.

If, after the book is laid down, the reader feels a certain amount of imprisonment within the four walls of his room and in his wonder goes to look and to ask for more of the same fare, "One, Two, Three—Infinity" has succeeded in its purpose.

The book is well illustrated by drawings of the author and is written in his usual entertaining style. A pocket book edition by Mentor is printed.

I once had a classmate named Jessar
Whose knowledge grew lesser and lesser.
It at last grew so small
He knew nothing at all
And now he's a Thermo professor.

Then there was the case of the young army doctor in the South Pacific, who had diagnosed the ailment of a sergeant, but knowing he could do little with his limited facilities, he wired the base hospital: "Have a case of beriberi. What shall I do?"

The message was taken by a young technician at the base who wired back: "Give it to the engineers. They'll drink anything."

* * *

One of our present troubles seems to be that too many adults, and not enough children, believe in Santa Claus.

* * *

Miriam had not been doing very well in history, although her marks in every other course were high. One day she was called into the professor's office for a conference.

"I do anything if I could pass, Professor, anything at all."

"Anything?"

"Yes, anything."

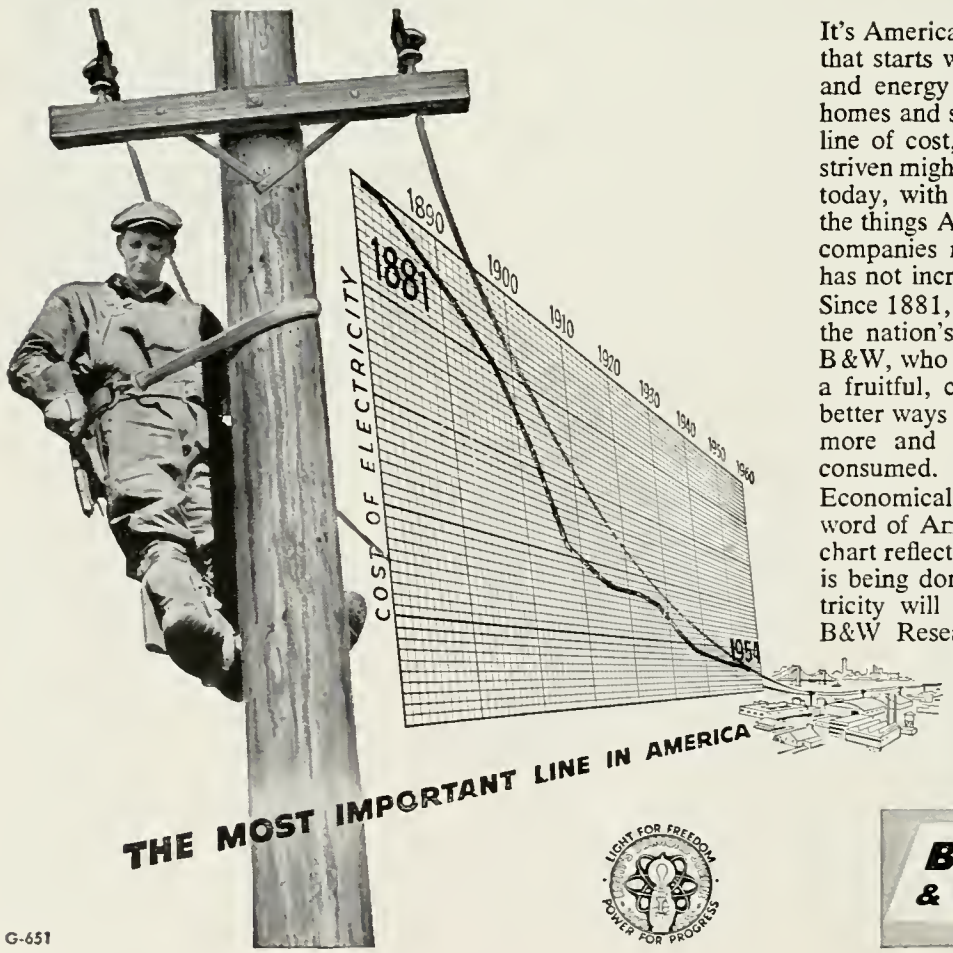
"Are you sure?"

"I just have to pass, Professor, yes, I'd do anything."

"Hmmmm, what are you doing Friday night, Miriam?"

"Why, nothing at all, Professor."

"Well, Miriam, I think you might do a little studying."



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Donald W. Sundstrom received his B.S. degree in Chemical Engineering from Worcester Polytechnic Institute in 1953. He's currently studying for an M.S. degree and expects to receive it next year. Like other engineering students, he's asking a lot of searching questions before deciding on a permanent employer.

Don Sundstrom asks:

What are my chances for advancement in a big firm like Du Pont?

Gerald J. Risser, B.S. Chem. Eng., Univ. of Wisconsin (1937), is now assistant manager of the Engineering Service Division in Du Pont's Engineering Department, Wilmington, Delaware.

Jerry Risser answers:

I THINK I know exactly what's behind that question, Don, because the same thing crossed my mind when I first graduated and looked around for a job. That was about seventeen years ago, when the Du Pont Company was much smaller than it is today. And there's a large factor in the answer, Don, right there! The advancement and growth of any employee depends to a considerable degree on the advancement and growth of his employer. Promotion possibilities are bound to be good in an expanding organization like Du Pont.

Right now, for example, construction is in progress or planned for three new plants. That means many new opportunities for promotion for young engineers. And, in my experience, I have found it is a fundamental principle of Du Pont to promote from within the organization—on merit.

My own field, development work, is a natural for a young graduate, because it's one of the fundamental branches of engineering at Du Pont. There are complete new plants to design, novel equipment problems to work on, new processes to pioneer—all sorts of interesting work for a man who can meet a challenge. Many of the problems will involve cost studies—some will require evaluation in a pilot plant—but, in every case, they'll provide the satisfactions which come from working with people you like and respect.

All in all, Don, your chances of advancement on merit are mighty good at Du Pont!

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Biography . . .

Omar Khayyam

by Jim Piechochi, Aero E. '56

Perhaps it was the very soul of the ill-fated Hasan Ben Sabbah, crying out in repentance of his evil life, or the victimized Oriental known as Nizam-ul-Mulk beseeching the Tartar gods for vengeance that have raised the name of Omar Hhayyam to the position that it occupies today. But fate can never be satisfied if the true credit for the fame of the Sufistic Khayyam is not placed in the hands of one minor English poet, who, after seven centuries, made famous the philosophies of the astronomer-poet of Persia. This Englishman, Edward

JIM PIECHOCHI

Jim is a newcomer to The Technograph staff on this campus. Heretofore he has periodically written articles for us from Navy Pier. We are hoping for more good work from him before he graduates in February of 1956.

Fitzgerald by name, striving to seek a connection between the ancient Persia and the Ireland of his predecessors, stumbled onto the exotic depths of Persian thought and the writings of Omar. So fascinated was he by al-Khayyam's meditations that he began a feverish study of the works of the somber Saracen of Naishapur. Six years later, in 1859, he published at his own expense a thin paper-bound pamphlet which sold for the modest price of five shillings. The printer quickly reduced the price and one year later a copy could be picked up by interested Englishmen for a penny. Many copies collected dust on bookshelves, while others were rapidly discarded, literally forced into obscurity by a flippant toss into a London gutter. Fitzgerald became no richer or poorer, nor was he raised one notch higher into national prominence. He simply remained at his same calm, unnoticed position on those broken steps that lie ever so close to the dark chasms of obscurity. Then one day a copy fell into the hands of the celebrated Dante Gabriel Rosetti, and so surprised was he by those shouting, hoping, and lilting quatrains that he carried the book with him wherever he went and quoted often from it. Burton and Swinburne spread Dante's enthusiasm and soon all of England was scouring those same dust-covered bookshelves in search of that little booklet with the now-famous title—The Rubaiyat of Omar Khayyam. This movement created one of the biggest revolutions in literature of that period. In 1929, a New York collector bought one of the original copies for eight thousand dollars. But to speak of revolutions is to speak of thoughts, and in speaking of thoughts it is very often that the thinker is discarded and separated from that which he originates. It was the rediscovery of the Rubaiyat that raised into full view that little known poet-astronomer-mathematician of mysterious Persia —Khayyam, which means tentmaker.

He was born at Naishapur in 1049 A. D. and died there in 1123. He was the son of Abraham the Tentmaker, and his full name was Omar ibn Ibrahim al-Khayyam, Giyat ed-din Abul Fath. In his youth he became the student of the aged teacher of Naishapur, Iman-Muaffak the Sufi. He studied with two friends who were destined to have a great effect on his life, and they were the Nizam-ul-Mulk and the evil Hasan ben Sabbah. All were of extraordinary intelligence and sharpness of wit, and realizing that they were the products of the wise Iman and certainly destined for good fortune, they mutually vowed that the first to achieve fame would share it with the remaining pair. After years passed, it was Nizam-ul-Mulk who reached the goal first, as he was elevated to the position of Grand Yizir to the Selpukian sultan. Alp-Arslan the Son, and his successor Malik Shah the Grandson. Omar and Hasan approached Nizam and the goodly Yizur, remembering the schoolday agreement, sealed his part in the bargain. To Hasan he bequeathed the position of Hajib, which means chamberlain. To Omar he offered a similar lofty title which the former promptly refused, accepting instead a modest annual allowance of 1200 mithkals to pursue a comfortable life of literary and scientific endeavor. Soon the ungrateful Hasan, seeking to replace Nizam in the Sultan's favor, was banished from the court screaming oaths of vengeance upon his old schoolmate. Nizam himself was banished at a great age and left at the mercy of the Ismalite Fidais, a sect of the Assasins, who attacked and stabbed him to death. Hasan had made good his revenge.

Omar, however, accepted his fate with more reserve than did Hasan. Upon the death of the Sultan Alp-Arslan, he became the royal astronomer of the court and was placed in charge of a project to revise the calendar. His mathematical observations continued and he was contented with the many hours of meditation his life afforded. His literary efforts were no doubt the outlet for his probing mind which forever busied itself not only with mathematical investigations, but also with an almost frantic search for proof of the existence of an after-life. Finding no answer to the latter problem, he settled down to an earth-bound existence which he reasoned could only be promoted by a dire effort to satisfy the senses. ("Ah, make the most of what we yet may spend, before we too into the Dust descend.") His somewhat pantheistic views were in direct contradiction of the Sufi religion, which he scorned and discarded with the wave of his hand. His freedom of thought, so vividly reflected upon in the haunting strains of the Rubaiyat, was always a matter of discussion in the court and a source of danger to his life, as the Sufi constantly tried to entrap him. Hence, al-Khayyam had a hard life, loved and respected as a scientist, and rejected and scorned as a philosopher and thinker. True enough, any analysis of Khayyam's motives will create skepticism among most men, but any study of his literary style and presentation will invariably result in his being called an expressive genius, with, of course, a silent nod and proper thanks to his collaborator, Edward Fitzgerald. But like most great artists his literature was not accepted by those of his time. "A great scientist, the Iman of Khorasan," they shouted in their courts of Justice, but speak of philosophy and they called him fool. He died peacefully in the town of his birth "sans wine, sans song, sans singer, and—sans End!"

Any analysis of Omar's mathematical achievements cannot proceed without a study of the pre-Khayyam mathematics of the Greeks and the Egyptians. The infant study of algebra was said to have originated with the term al gibr w'al mukhaba, a title occuring on every Saracen work on the subject since 825 A. D. The Egyptians, led by Ahmes (c. 1600

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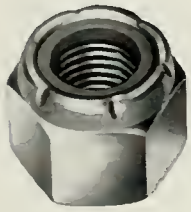

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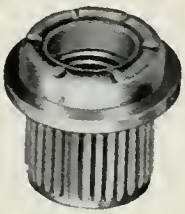

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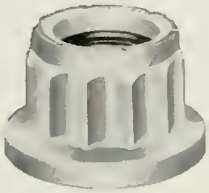

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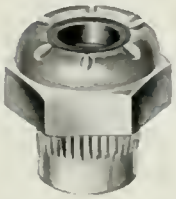

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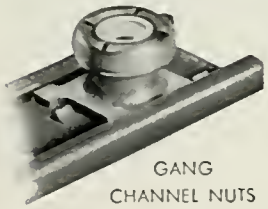

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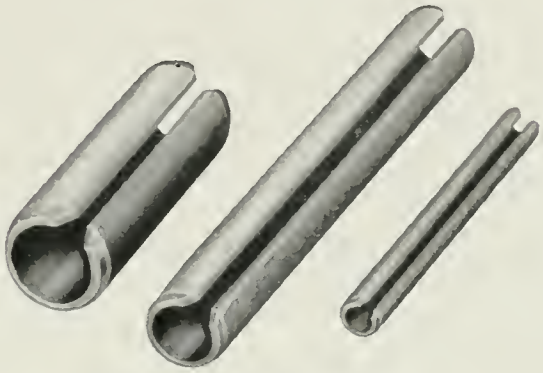

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B. C.) solved simple linear algebraic equations, while the Greeks and Hippocrates solved algebraic problems of great complexity. Aristotle (c. 340 B. C.) explained basic mathematical concepts in his many treatises on logic. Archimedes solved various word problems, including the one which baffled the Egyptians, namely, to cut a sphere by a plane so that the two segments formed are in a given volumetric ratio. The Arabians contributed heavily to early mathematical development. Mohammed ibn el-Leit interested himself with the cubic equations, the problem of trisection of an angle, and the solution of fourth degree equations which he later achieved by the method of intersection of conics. The last Arab of importance before Khayyam was al-Karkhi (c. 1020).

A vast difference is noted between Greek and Arab mathematical thought, the Greeks, with their great strides forward along the lines of abstract philosophy and all their thought seemingly channeled to exhibit their skill in deep thinking, and the Semitic Arabs with their own philosophy effecting a mathematics which mirrored their general pragmatic outlook, both paved the way for the algebra of Khayyam.

"By the help of God and his precious assistance, I say that algebra is a scientific art." So said Omar Khayyam of the study in which he excelled. Biographers have depicted al-Khayyam as a true mathematician, exceeding in certain aspects the thinking of Diophantus and Al Kwarizimi, although Omar completely abandoned the use of symbols or word abbreviations and relied on word or phrases to describe his unknowns. For example, he termed the successive powers of unknown "roots" or "sides" as "square," "square - square," "square-cube," "cube-cube," etc., and negative "sides" were called "part of root," "part of square," etc. Omar solved his equations, some of them the more difficult non-linear type, by the method of intersection of conic sections. That is to say, he formed a typical solution of the form presented and applied his solution to the problem at hand. He believed that this was the only method that could be applied to the solution of the cubic equation, which he called unsolvable by calculation. By far his greatest contribution to the science was his thorough classification of the cubic equation, often referred to by some of the later mathematicians as extremely fine pieces of work. But Omar was responsible for some classical blunders. He believed there to be no analytical method to the solution of the cubic equation he so systematically organized, and that biquadratic equations were unsolvable by geometric construction. He over-looked the fact that the cubic equation has three solutions, losing roots by using only one side of the hyperbola employed in his geometric construction. One bright feather in the Persian's hat was his solution to the age-old problem of constructing an equilaterial trapezoid whose base and sides are of some given length and whose area is given. In the solution of equations higher than the second degree he had no rival before or in his time.

Another achievement of the "big silent" Saracen which cannot be overlooked is his reorganization of the calendar. This he accomplished by order of the sultan in 1079 A. D., which is, incidentally, the beginning of an era of man's attempt to record and systematize the universe to his daily life. Omar grouped the years into cycles of thirty-three years each, giving the year 365 days, and making every fourth year a leap year of 366 days. This revision gave every cycle eight leap years with an interval of five years between the last leap year of each cycle with the oncoming one in the next cycle. This makes Omar's average year 365 days, five hours, forty-nine minutes, 5.45 seconds. Astronomically speaking, his year was 19.007 seconds too long. It is interesting to note that the Gregorian year is 25.557 seconds too long, necessitating the dropping of a leap year every 4545 years. If Omar's calendar were adopted today, one leap year would have to be omitted "only" every 3381 years—a one-third step toward perfection!

The seventy-four years of Omar's life were filled with achievement. But the years of achievement were marked by his constant soul-searching mental attitude, which, if not resplendent in his mathematics, certainly comes shining fatalistically through in his Sufistic quatrains, or rubaiyat. His search for the after-life ended in his complete abandonment of the Tomorrow in exchange for the Today, which, after all, "has outlasted so many Tomorrows." He constantly felt revoked by his dark Muezzin crying from the Tower of Darkness, "FOOLS! Your reward is neither here nor there." Perhaps it was his wisdom or his foresight which made him speak out one day to his pupils, Kwajah Nizam of Samarcand, "I desire that my tomb shall be in a spot where the north wind scatter roses upon it." This shocked Nizam for it was an intense belief that no man might know his own burial grounds. Later Lizam visited his teacher's resting place, "and lo!, it was just outside a garden, and trees laden with fruit stretched their boughs over the garden wall, and dropped their flowers upon his tomb so that the stone was hidden under them."

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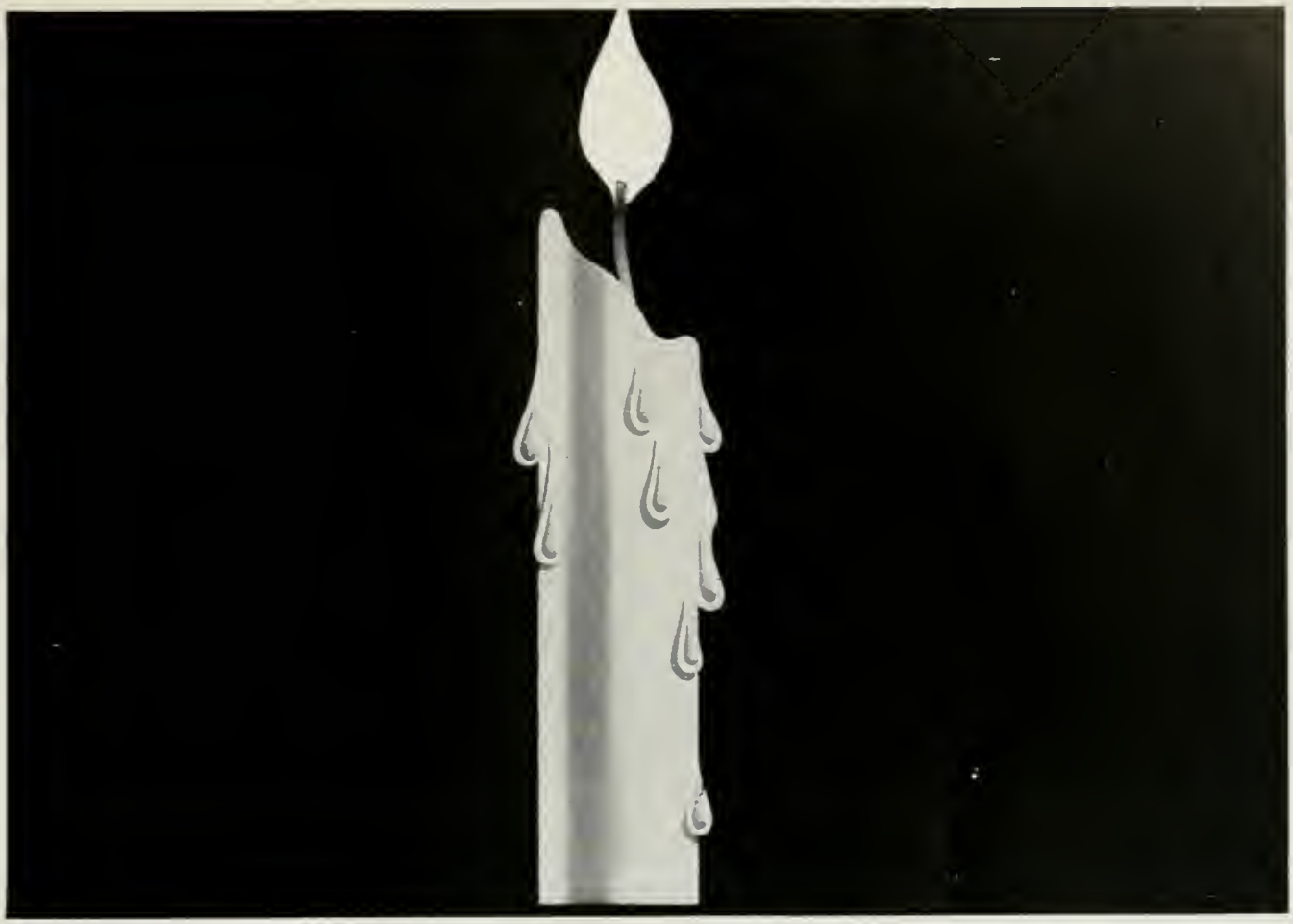

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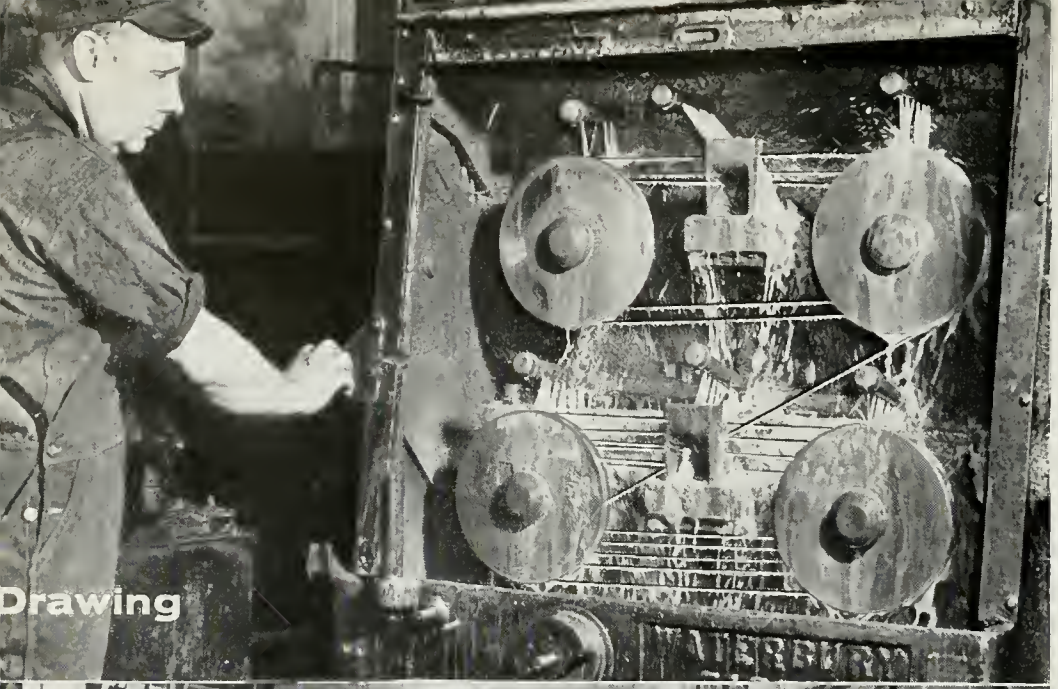

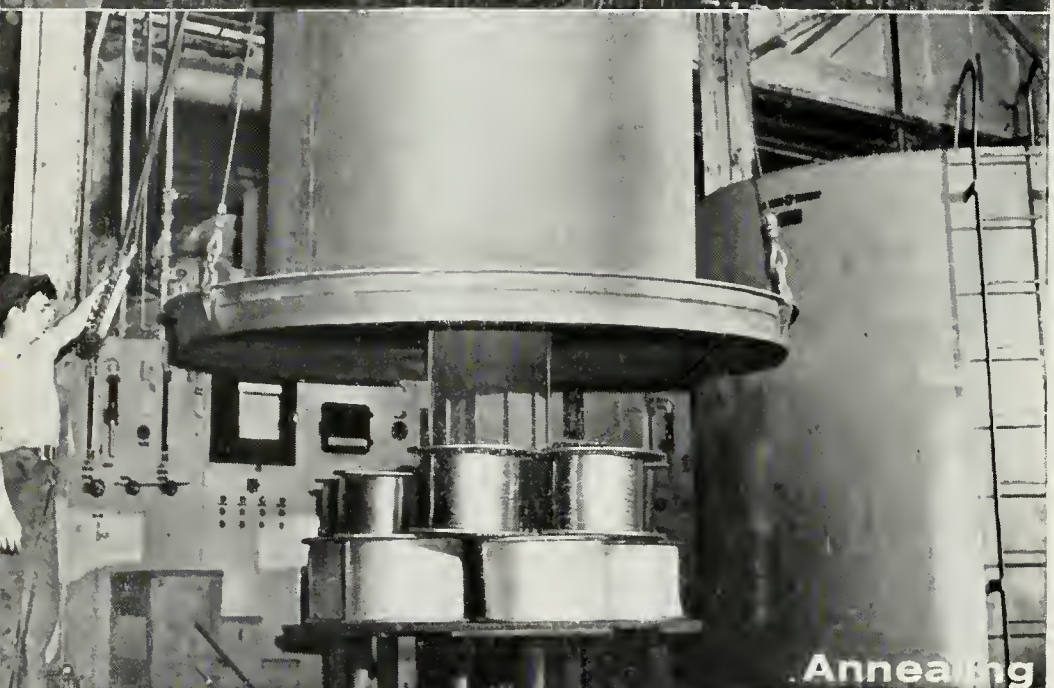

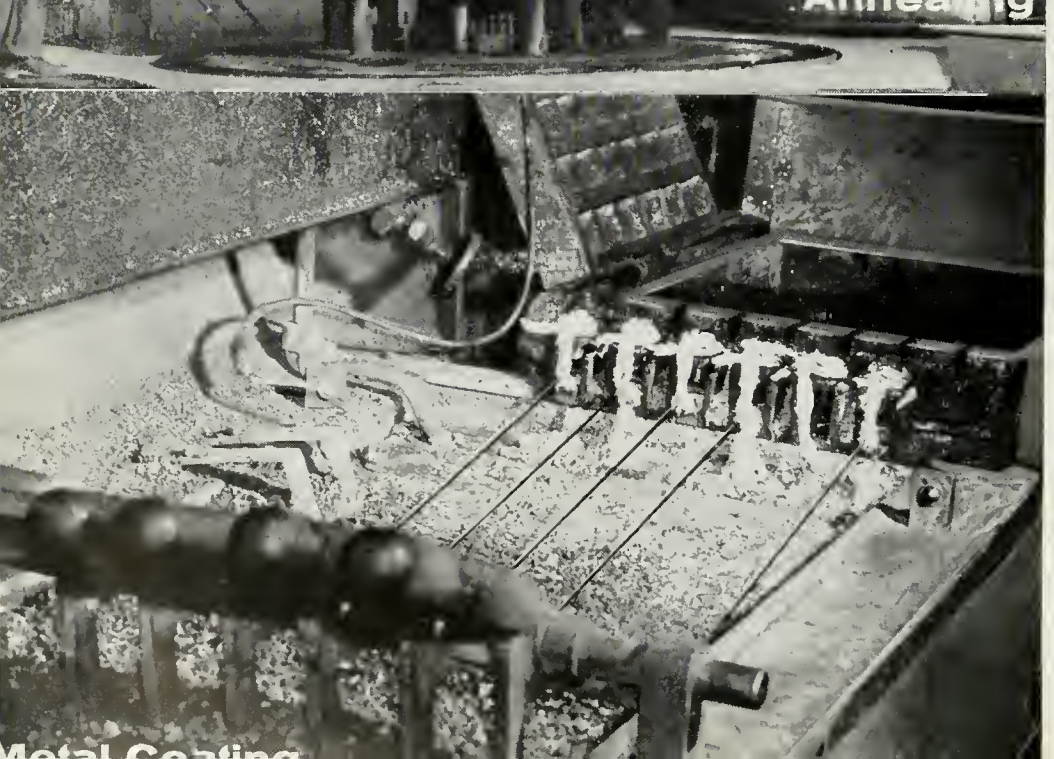

The
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Electrical conductors for wires and cabl are generally made from either aluminu or copper. Except as noted below und annealing and metal coating, essentially t same method is used in preparing electric conductors from these metals.

Preparation of Wires

The metal, after purification at the refiner is cast into billets about four inches squa and about four feet long. For use in electric conductors, this billet is reduced in cros sectional area to produce the flexibili required in the finished wire or cable. F example, weatherproof wire for outsi power distribution, where little flexibility required, contains conductors that are sol or made of relatively few wires. For heat cord and welding cable, where excessi flexing in service occurs, the conductors a made up of a large number of small wire Between these two extremes there is a wi variety of cable constructions requirin numerous sizes of wires.

The reduction in area of the billet begun on the rolling mill where the billet reduced to rods, the commercial sizes which vary from about one-quarter to thre quarters inch in diameter. Rods are reduce to final wire sizes by drawing through succession of dies of gradually decreasin diameter, the reduction in area per die draft being about 30 per cent.

Drawing

The drawing of wire increases its hardne and tensile strength and decreases its elo gation and electrical conductivity. Sin elongation determines the ability of material to withstand repeated bending flexing, it follows that the drawing of wi reduces its flexibility. Except where streng is important, as in weatherproof wires su ported aerially, practically all electrical co ductors should have greater flexibility an electrical conductivity than that provide by hard-drawn wire. Both flexibility an conductivity are improved by annealin hard-drawn wire.

Annealing

Annealing consists of subjecting the wire coils or on spools to a temperature of abo 650°F for about two hours. Large coils spools may require a longer time and high temperature. To prevent tarnishing durin the annealing of copper wire, it is nece sary to anneal in an inert (oxygen free) a mosphere. This precaution is not necessar in annealing aluminum wire. Annealing hard-drawn wire increases its ultima elongation about 2000 per cent and ele trical conductivity about 3 per cent.

US RUBBER

eparation
lectrical
conductors

Metal Coating

protected copper in contact with rubber ulation combines with sulphur in the in- ation to form copper sulphide. This re- es the conductivity of the copper and kes it brittle and difficult to solder. thermore, copper in contact with rubber, elerates the combination of rubber with gen and hence promotes the deteriora- n of rubber insulation. To prevent this tually harmful action, copper for use in ber-insulated wires and cables is pro- ted with either a thin continuous coat- of inert metal, such as tin, lead, or d-tin alloy on the individual wires or a arator consisting of a wrap of threads or e over the uncoated conductor.

Metal coating consists of passing the in- idual copper wires successively through dilute hydrochloric acid, (b) molten tal or alloy, (c) a wiper, (d) a cooling bath d finally to a take-up reel. The hydro- oric acid cleans the surface of the copper uring a perfect union between the copper d the coating metal and a complete cov- ge of the copper by the coating metal. e wiper removes the excess coating ma- ial and produces a smooth surface on coated wire.

Metal coating or a separator is not required on aluminum conductors for rubber insulated cables since aluminum does not combine readily with sulphur and does not accelerate the deterioration of rubber.

Stranding of Conductors

As pointed out above, the purpose of wire drawing is to so reduce the cross-sectional area of the billet or rod that a conductor of the required flexibility can be produced. In addition to adequate flexibility, the conductor must also have sufficient cross-sectional area to provide the current carrying capacity and voltage drop required for a particular application. In general, the service conditions and current carrying capacity of wires and cables are such that conductors of greater flexibility than is obtained with a single wire (solid conductors) are required. Solid conductors are used generally only on sizes 6 Awg. and smaller conductors and then only for fixed (not portable) installations. Most conductors, are, therefore, made up of more than one wire.

The formation of a conductor by bringing together the required number of wires is known as stranding, and the conductor thus formed is known as a stranded conductor. There are two fundamentally different types of stranding, namely, bunched stranding and concentric stranding. These differ in the manner in which the wires are assembled to form a conductor.

Bunched Stranding

In bunched stranding, the required number of wires are simply twisted together with no attempt being made to control their relative positions within the group. The length of the group requiring a complete turn of any one wire is known as length of lay of the strands. The length of lay varies widely with the number and size of the wires and the flexibility desired in the conductor.

Concentric Stranding

In concentric stranding the individual wires are laid up symmetrically in the form of a geometrically compact group. For example, six wires will lay snugly around one central wire, twelve wires will lay around a group of seven, etc. All of the wires are laid up around the same or a common center, hence the term "concentric stranding". The number of wires in the outer layer increases by six and the total number of wires in the assembly becomes 1, 7, 19, etc. The wires in any one layer are cabled or twisted around the central core with a definite length and direction of lay. The direction of lay of the wires is reversed in alternate layers to equalize the torsional forces resulting from twisting the wires about the central core. The length of lay depends on the size of the individual wires and the number of layers in the conductor.

Rope Stranding

A modification of concentric stranding known as rope stranding is used chiefly in the preparation of large flexible conductors for portable and welding cables. This differs from concentric stranding in that a group of wires, known as ropes, instead of individual wires, are laid up in a geometrically compact form of six around one, etc. These groups of wires may be either concentric or bunched stranded. This type of stranding makes possible building up a conductor with a greater number of wires than can be produced by concentric stranding on a machine with a given number of spools.

Other Strandings

Other types of conductor strandings, such as "sector-shape", "compact-strand" and "segmental" are used for special purposes to reduce conductor diameters and conductor losses.

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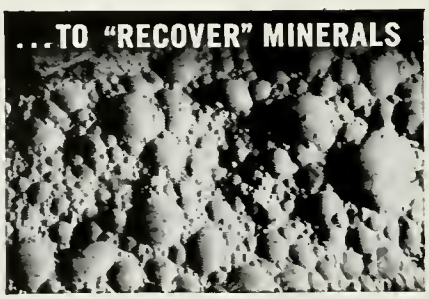

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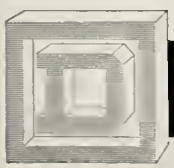

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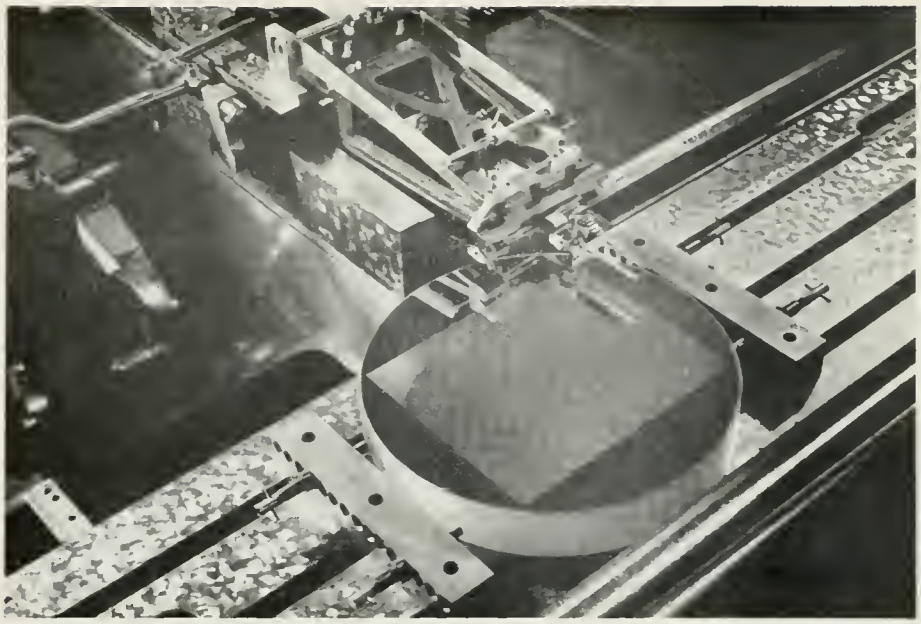


A large finished grating in position at end of ruling cycle. The complex mechanism of the diamond carriage is shown. (All photos courtesy Bausch & Lomb Optical Co.)

Another Rainbow . . .

DEFRACTION GRATINGS

by Larry Kiefling, M. E. '56

When a light wave moves past a corner, the corner acts as a source of light and the light seems to bend around the corner. This phenomenon can be observed only when the dimensions of the corner are comparable to the wavelength of the light and when the source of light is small.

If a large number of edges or slits are placed close together, the light from each of these will interfere with the light from the others and form an interference pattern. If the slits are equally spaced, the interference lines for a given color will be parrallel to each other and can be focused by a lense or mirror to form an image of the slit. This arrangement of many equally spaced slits is known as a diffraction grating. The various colors of light will interfere at different angles and form a spectrum. Diffraction gratings produce a series of spectra which are numbered in their order from the center. The spectra produced by diffraction gratings are known as rational spectra because the sin of the displacement angle is proportional to the wave length of the light.

LARRY KIEFLING

Larry is a junior in Mechanical Engineering from Cowden, Ill. He is a member of ASME, and Phi Eta Sigma, freshmon honorary.

Some of the earliest diffraction gratings were made by Joseph Fraunhofer (1787-1826). They were constructed of fine wires .04 to .06 mm in diameter and spaced .0528 to .6866 mm apart. Modern diffraction gratings are made by ruling lines on metal or glass with a diamond point.

The problem of ruling a large number of straight, equally spaced, parallel lines is a difficult one. Fraunhofer (1821), Nobert (1846), and Rutherford (1870) were among the first to rule small gratings. Rowland at Johns Hopkins University was the first to rule high quality gratings. At the present time only Johns Hopkins University, Mt. Wilson Observatory, and Bausch & Lomb Optical Co. are capable of producing gratings 100mm or more in width.

High resolving power is maintained by holding the spacings of the grooves to within .01 microns. (A micron is .001 mm.) Extreme precautions are taken to insure this accuracy. The gratings are made in a special underground laboratory such as the one shown. The temperature of this laboratory has been held within .01°C for periods of over two weeks. The maximum vibration of the ruling engine is .025 microns.

The engine shown was built by Michelson, rebuilt by Gale, and presented to Bausch & Lomb by the University of Chicago. The engine is capable of ruling gratings up to 150 mm in length and 300 mm wide. However, more work must be done on the machine before this full area can be used. At present the largest gratings ruled are 153 x 203 mm. Gratings ranging from 60 to 2,160 grooves per mm are ruled! The precision screw has been studied and a brass cam cut to exactly correct the error. Engraving is done with a carefully shaped diamond point. The diamond

QUARTZ CRYSTALS

How a 1¼ hour "gem-cutting" operation became an 8-minute mechanized job

PROBLEM: Preparing quartz crystals for use as electronic frequency controls calls for the highest degree of precision. So much so, in fact, that prior to World War II skilled gem-cutters were employed to do the job.

But during the war, there were not enough gem-cutters to keep up with the demand for crystals in radar, military communications and other applications.

Western Electric tackled the job of building into machines the skill and precision that had previously called for the most highly skilled operators.

SOLUTION: Here is how quartz crystals are made now—by semi-skilled labor in a fraction of the time formerly required:

A quartz stone is sliced into wafers on a reciprocating diamond-edged saw, after determination of optical and electrical axes by means of an oil bath and an X-ray machine. Hairline accuracy is assured by an orienting fixture.

The wafers are cut into rectangles on machines equipped with diamond saws. The human element is practically eliminated by means of adjustable stops and other semi-automatic features.

The quartz rectangles are lapped automatically to a thickness tolerance of plus or minus .0001". A timer prevents overlapping. Finally, edges are ground to specific length and width dimensions on machines with fully automatic microfeed systems.

Most of these machines were either completely or largely designed and developed by Western Electric engineers.

RESULTS: With skill built into the machines —with costly hand operations eliminated— this Western Electric mechanization program raised production of quartz crystals from a few thousand a year to nearly a million a month during the war years. This is just one of the many unusual jobs undertaken and solved by Western Electric engineers.

Quartz stones are cut into wafers on this diamond-edged saw, with orientation to optical axis controlled by fixture. This is just one of several types of machines designed and developed by Western Electric engineers to mechanize quartz cutting.

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

Manufacturing plants in Chicago, Ill.; Kearny, N. J.; Baltimore, Md.; Indianapolis, Ind.; Allentown and Laureldale, Pa.; Burlington, Greensboro and Winston-Salem, N. C.; Buffalo, N. Y.; Haverhill and Lawrence, Mass.; Lincoln, Neb.; St. Paul and Duluth, Minn. Distributing Centers in 29 cities and Installation headquarters in 15 cities. Company headquarters, 195 Broadway, New York City.

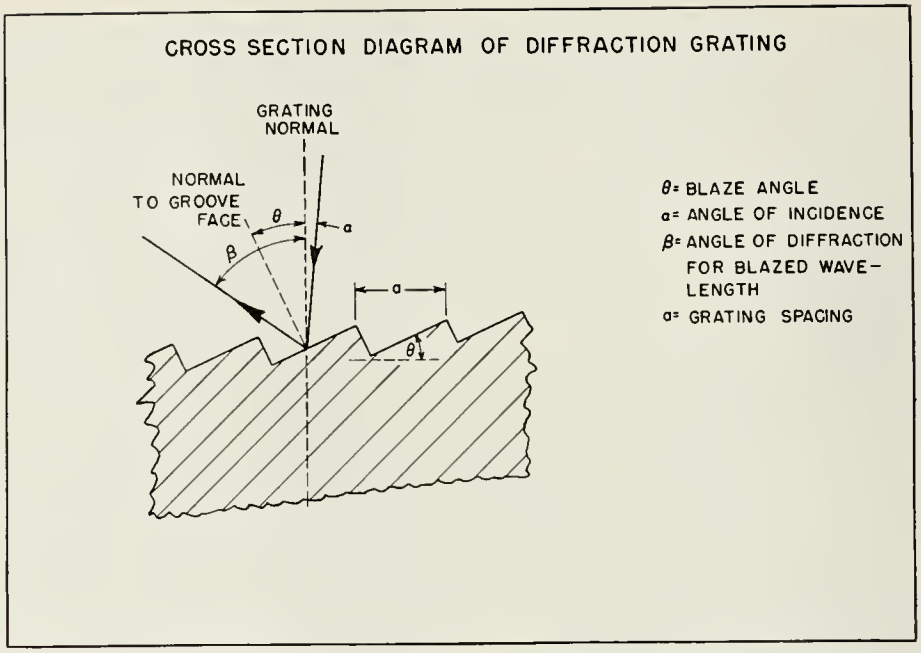
carriage is carefully designed and built to give the same straight line motion with each stroke.

Master gratings are ruled on blanks of borosilicate crown glass coated with a heavy layer of vacuum evaporated aluminum. The actual ruling of a master grating is a long slow process. Adjustment and orientation of the ruling diamond may take more than a day. Twenty five points on the engine must be checked, lubricated, or adjusted. The engine is allowed to run for 18 or 20 hours to allow it to come to its final operating temperature. The normal ruling speed is 10 strokes per minute or 600 per hour. On a grating with 600 grooves per mm, the rate of ruling is 1 mm per hour or about 1 inch per day. A wide variety of tests are run on the finished gratings to see that they meet all specifications.

Much work has gone into the development of a process for the manufacture of a diffraction grating which maintains the quality of the master grating. The following process is used by Bausch & Lomb for making their "Certified Precision" gratings. The grooves are formed in a thin layer of plastic which adheres to a glass backing plate. The plastic is not subject to deterioration but is easily damaged by wiping, brushing, or touching the surface. Reflectance gratings are coated with aluminum. This coating can be renewed if the aluminum becomes stained. Transmission gratings can be used only in the regions of the spectrum where glass is transparent.

The number of grooves per mm or its reciprocal, the grating constant is of great importance in determining the properties of a grating. The groove width must not be less than the longest wave length to be studied. The grating acts chiefly as a reflector for longer wavelengths. This property is useful where it is desirable to separate visible light from infrared by the use of fine diffraction gratings for the infrared.

The first order angular dispersion of a grating is directly proportional to the number of grooves per mm. It is possible to get greater dispersion by using a grating in a higher order or by using lenses of a longer focal length to get a larger grating to spectrum distance. There is an upper limit of about 900 grooves per mm for practical transmission gratings. This is because that light cannot escape from the groove face at an angle exceeding that of the groove face.

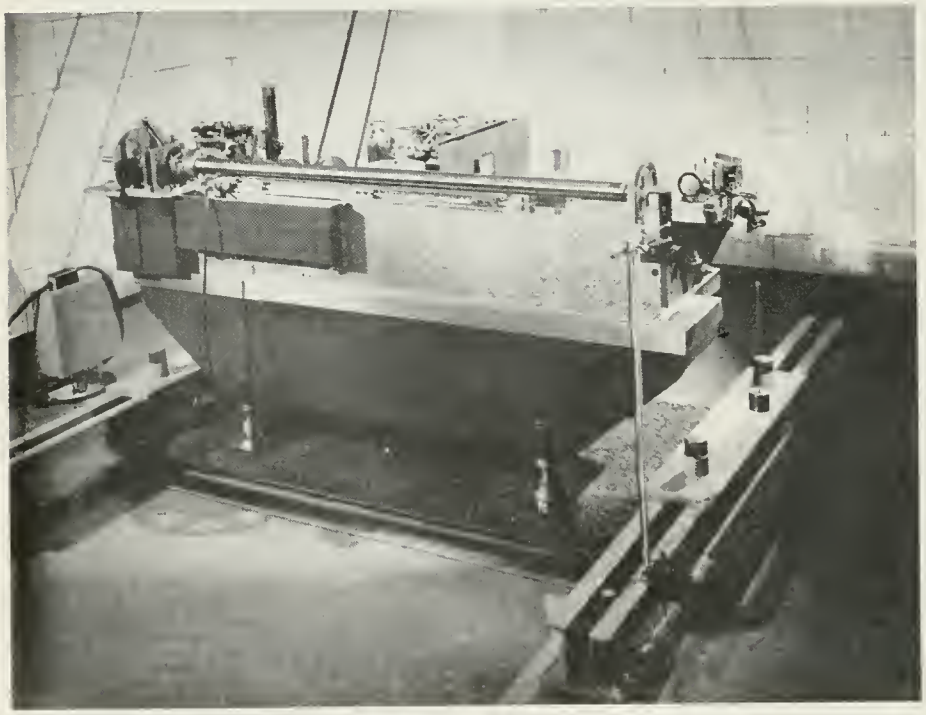


Profile view of a reflectance grating. Transmission gratings have the same shape.

Modern diffraction gratings are blazed by controlling the groove face angle so as to concentrate the spectral energy in the desired region of the spectrum. The wanted angle is found by using the wavelength at the center of the desired region and calculating the groove face angle for which the specularly reflected light will have the same angle as the diffracted light. Gratings ruled with grooves should have two different blazed regions, one on each side of the zero order. The gratings are usually designed with a relatively small angle on one side for use in the first or second order spectra and a steep side which can be used for high order work. This makes it possible to use the same grating for a wide variety of work.

The blaze angle of reflectance gratings is calculated from the fact that the angle of reflectance is equal to the angle of incidence. The blaze angle in transmission gratings is calculated on the assumption that the angle of incidence is mormal to the ruled surface and that the ray passes thru the glass and emerges from the ruled surface. The blaze angle for a transmission grating is the groove face angle that refracts the transmitted light of the blazed wavelength at the angle of diffraction for that wavelength.

Rowland ghosts are caused by periodic



The Michelson-Gale ruling engine. Gratingswith up to 2,160 rulings per mm. can be made.

1927 — pioneer airliner, Boeing 40A, 144 m.p.h.

1954 — America's first jet transport, the Boeing Stratoliner, 550 m.p.h.

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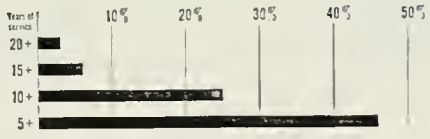

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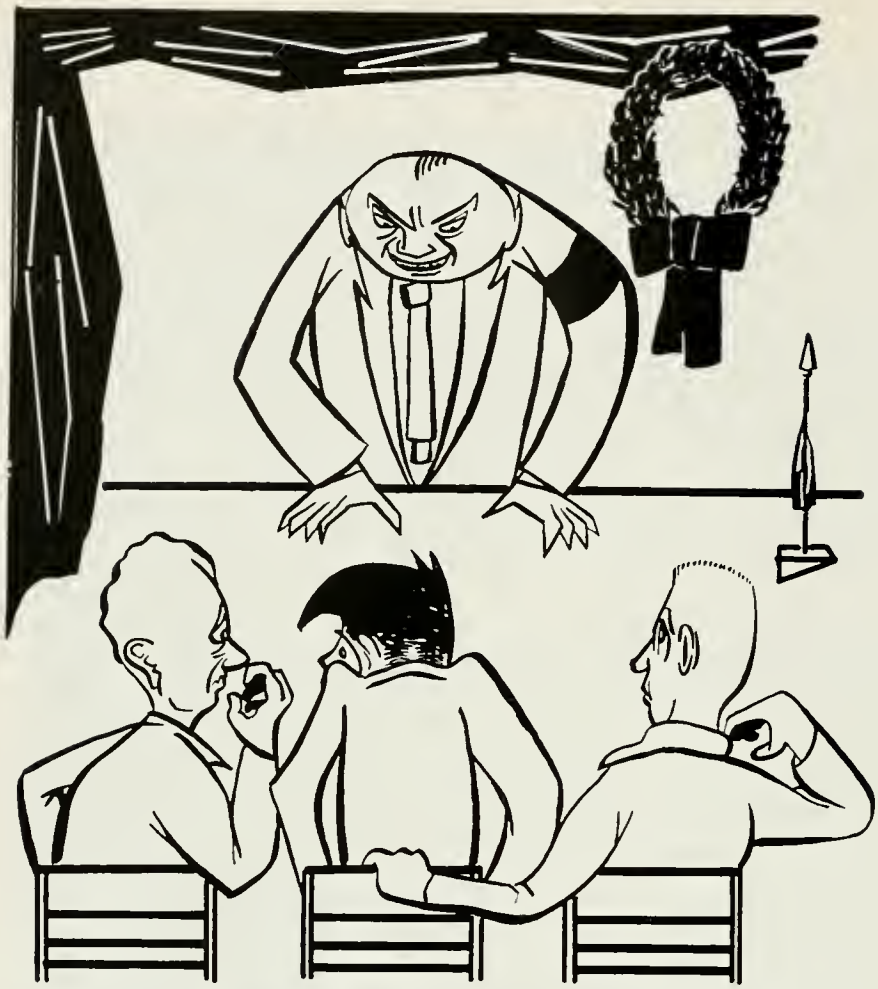
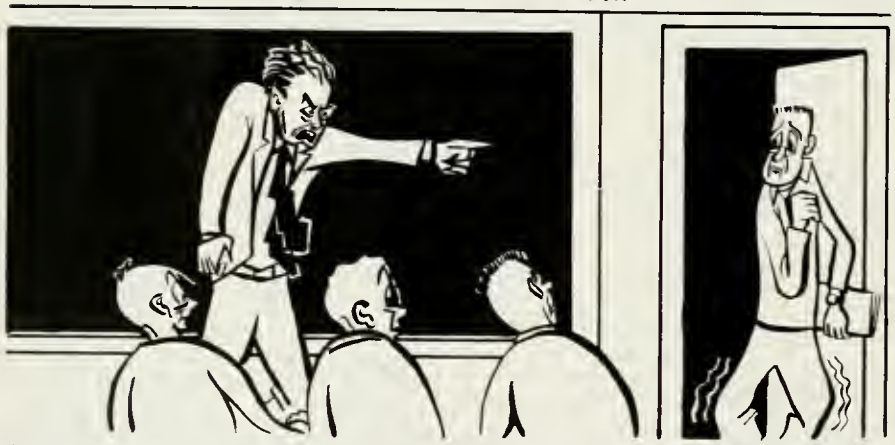
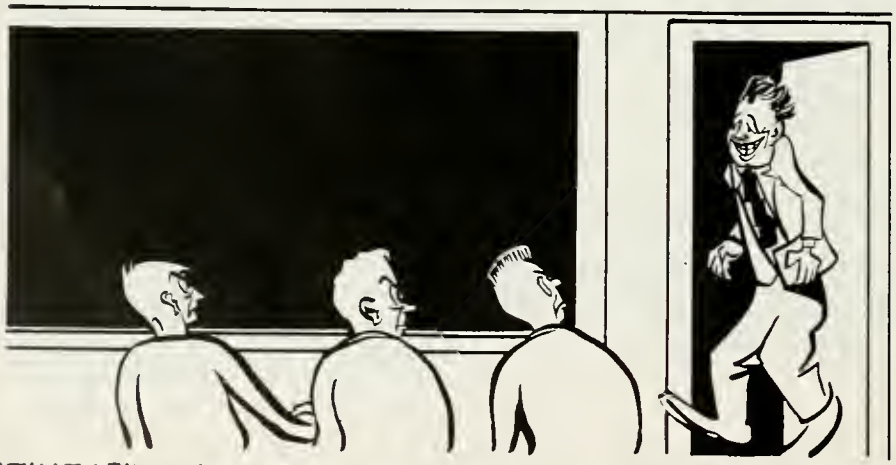


"IF I REMEMBER CORRECTLY, I SAID THERE WOULD BE AN EXAM TODAY."



"NO EXCUSES! YOU KNOW I DON'T TOLERATE TARDINESS!"



"THAT LI'L OL' ALARM CLOCK-HA! HA!-GOES BAD SOMETIMES..."

THIS IS

"GET AN EDUCATION! DON'T WO
ABOUT MARKS-BY THE WAY, YO
FINAL EXAM WILL BE
50% OF YOUR GRADE."

"REMEMBER, T.V. IS BAD FOR STUDIE
BLAST OFF, RANGERS!-ER-CLASS DISSM

OLLEGE?

'S NOTHING, REALLY. JUST A NEW GRADING CURVE I'M USING - EVERYBODY FLUNKS!

NSHAW, LET'S STICK WITH THE .AB MANUAL, HMMMM?

"IT'S SO NICE OF YOU BOYS TO HELP ME TO MY OFFICE. HOW FOOLISH OF ME TO FORGET MY GLASSES."

THIS GENERATION! IRRESPONSIBLE! UNINTELLIGENT! WHY EVEN YOUR SLANG HAS REACHED A NEW LOW!

HEY, REF! YOU VACUUM HEAD! YOU SHMOE! GO! GO! YOU CRAZY TEAM! CLOBBER THEM!

Welded Steel Designs Cost Less Because:

1. Steel is 3 times stronger than gray iron.
2. Steel is 2½ times as rigid.
3. Steel costs a third as much as iron.

Ultimate savings are limited only by the ingenuity of the designer.

IMPROVES APPEARANCE SIMPLIFIES PRODUCTION CUTS COST

YOUR success as a designer depends on your ability to keep costs down on products you design. By properly applying the principles of welded steel construction, cost of manufacture can be reduced substantially because material costs are less, actual production is simpler. In addition, the product is stronger, more rugged, has modern appearance.

The examples show how one designer has applied the principles of welded steel to a machine base. The sturdy box-type construction of the steel design eliminates weight because of steel's greater strength and rigidity. Considerable machining, cleaning and finishing of former castings has been eliminated. More modern in appearance, nevertheless, the steel design costs 15% less to produce.

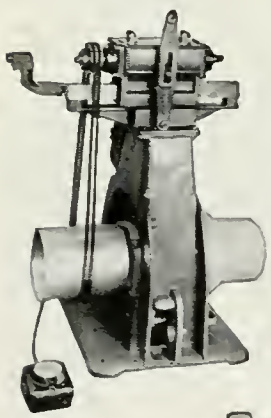


Fig. 1—Original Design *of wire straightening machine. Required considerable machining, cleaning and finishing prior to painting.*

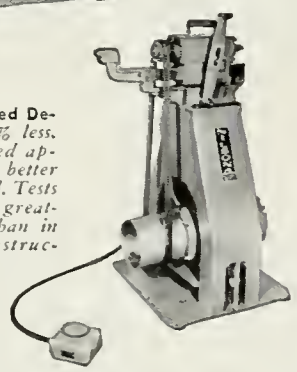


Fig. 2—Welded Design *costs 15% less. Has improved appearance . . . better selling appeal. Tests show base has greater rigidity than in original construction.*

IDEAS FOR DESIGNERS

Latest data on designing machinery for welded steel construction is available to engineering students in the form of bulletins and handbooks. Write:

THE LINCOLN ELECTRIC COMPANY
Cleveland 17, Ohio

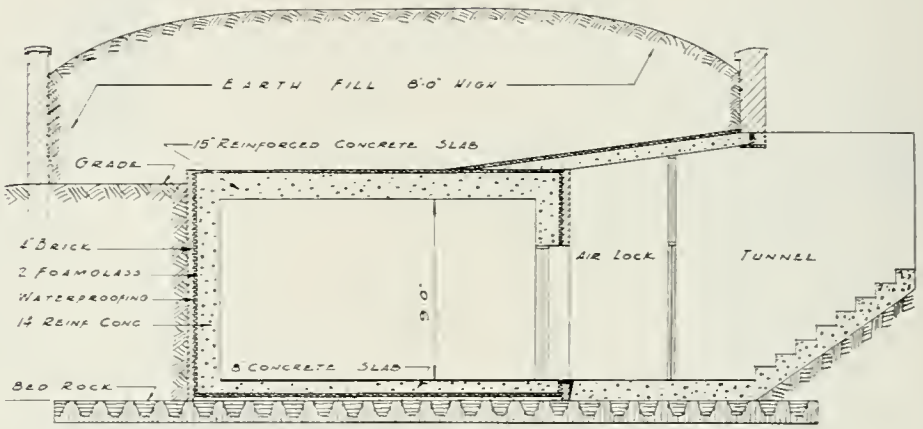
THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

error in the spacing of the grooves. Even the best precision screw ever made has a small amount of error that will produce ghosts. The error may result from inaccuracies in the screw itself or from improper operation of the bearings. Rowland ghosts appear as pairs of lines on each side of the parent line. Their position depends on the wavelength of the parent line and the number of grooves in each period of error. The intensity of the ghosts is proportional to the equare of the error and to the square of the order. Thus, the third order ghost is nine times as intense as the first order ghost.

Satillites are misplaced lines in the spectrum occuring very close to the parent line. They are caused by a small number of misplaced grooves in a localized part of the grating. If there are only one or two, they can usually be masked off.

The resolving power of a grating is a measure of its ability to separate two lines with a very small wavelength difference between them. High resolving power is achieved by freedom from satellites and through the use of high quality blanks. High quality lenses, mirrors, slits, and prisms must be used. Thermal air currents and vibration of the apparatus must be controlled to get high resolving power.

Usually, diffraction gratings are used in parallel light. A collimator lense or a concave mirror is used ahead of the grating while a similar arrangement is used following the grating. Mirrors are used to advantage when the system must be achromatic and when the work must cover a large spectral range.



Underground laboratory for ruling gratings. Extreme precautions are taken to avoid vibrations and to assure constant temperature.

Small Son: "I'm not afraid of going to the hospital, mother. I'll be brave and take the medicine, and do everything they ask me to—except I'm not going to let them palm off a baby on me, like you did. What I want is a pup."

Shortly before the invasion started, a general and his staff were watching a troop-carrying glider go by. From it came a carrier pigeon. Powerful field glasses followed the bird to a near-by field. A colonel raced over, got the bird, took the message from his leg, raced back, and breathlessly handed it to the general. He opened it with trembling hands, read it, cursed, and threw it on the ground. Then he walked away, his face a bright purple. The colonel waited a moment, then picked up the message. It read: "I have been sent down for being naughty in my cage."

* * *

Coed: "What wonderfully developed arms you have!"

Guard: "Yeah, I'm on the squad. By the way, were you ever on the track team?"

The colonel was lecturing a class of incipient officers. "A forty-foot flag pole has fallen down," he said. "You have a sergeant and a squad of men. How do you erect the flagpole again?"

The candidates thought, then made suggestions about block and tackle, derricks, and so on.

"You're all wrong," said the colonel. "You say: 'Sergeant, get that flagpole up.'"

* * *

Prof: "Why aren't you taking notes?"

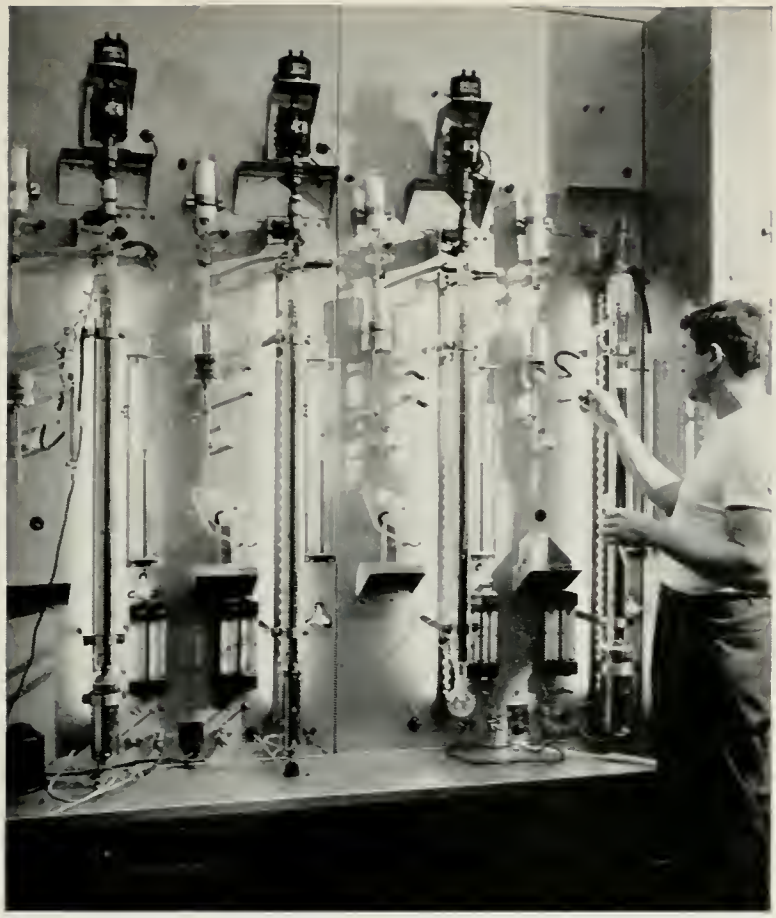
Student: "I don't have to. I've got my grandfather's."

* * *

An engineer is a guy who is educated in the art of developing new and different ways of making the same mistake.

* * *

A young man whose father had been hanged was filling out a college application. After the usual hereditary questions there was one asking the cause of the death of his parents. He thought awhile and finally put down this answer: "Mother died of pneumonia. Father was taking part in a public ceremony when the platform gave way."



A laboratory assistant (above) takes a fraction from one of the new miniature stills at Standard Oil's Whiting laboratories. The small charge in the large bottle (below) can be separated into 60 fractions in these exact stills.

NEW MINIATURE STILLS

Valuable Laboratory Aids

Some stills in oil refineries are gigantic devices which process 30,000 barrels of petroleum a day. Others are so small—and so exact—that they may take more than a week to distill five ounces of liquid.

Scientists at Standard Oil's Whiting laboratories now are working with eight new miniature stills so precise they are considered the finest of their type in the world. These stills, installed last year, are used to study liquids produced during research on such things as aviation gasoline, synthetic lubricants and detergents, plastics and plasticizers, and petrochemicals.

Laboratory men often work with only an ounce of liquid which may be made up of hundreds of different chemical compounds. Technicians usually wind up with individual "fractions" of about 1/50 of an ounce to be examined with mass and infra-red spectrometers, chromatography and other aids.

Another new research still at Standard Oil's Whiting laboratories has a packed column one inch in diameter and 16 feet high. It is probably the most efficient packed column ever built.

Such precise up-to-the-minute laboratory equipment helps Standard Oil scientists in their never-ending search for new and better products. And it offers young technical men the assurance that Standard Oil is a sound, progressive place to build a scientific career.

Standard Oil Company

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STANDARD

the lighter side . . .

SALTIER SAILORS

by H. V. Krone

On Sunday morning, November 16, 1947, I had my first look at the U. S. S. Canisteo, A. O. 99, a 25,000 ton navy oil tanker, aboard which I was to report for duty. The Canisteo was tied up at one of the piers in Philadelphia Navy Yard where she had just spent several weeks in dry dock. Although the ship was still relatively young, having been commissioned late in 1945, she was, nevertheless, considered to be one of the "saltier" ships of the navy, due to the fact that she had been a part of the last big Antarctic expedition. I was to find out later that the crew was equally as "salty," all of them being bonafide "Shellbacks," a status which can be attained only by sailing across the equator. Each carried a certificate to the effect that he was qualified for "spitting into the wind," and possessed various other talents which are peculiar to the "Shellback." I had gotten quite a complete story on the Canisteo from an ex-crew member whom I had met on the train ride from Norfolk Naval Receiving Station where I had been waiting for a duty assignment.

Early on the morning of November 17, the Canisteo pulled away from the Philadelphia pier and moved down the Delaware River heading out toward the Atlantic—my first cruise! It was rather short, however, as three miles down the river the ship tied up at a small island called "Fort Mifflin" where all hands worked up a nice sweat loading ammunition for the 40mm, 3 inch, and 5 inch guns.

My particular job aboard the Canisteo was maintenance of the electronic equipment, and my indoctrination into this job was not long in coming. About two hours after leaving Fort Mifflin, the P. A. system blared out my name requesting, rather forcefully, that I report to the bridge. I was shown into the radar room where I saw, for the first time, an S. U. type surface search radar set. The executive officer, who had shown me in, explained that the set wasn't working correctly and left with the words "fix it." The next several minutes being highly unsuccessful on my part, the other technician aboard, Charley Hays, who like myself was just out of the navy's one year training course in electronics and with no practical experience, was invited to join me in the effort. It was soon apparent that two green technicians were no better than one. To add to our misery, the ship had passed out of the Delaware into the Atlantic, and the roll of the ship gave us anything but a comfortable feeling. Around 2200, the electrical power system went out, including the auxiliary power unit, giving us a much needed excuse for giving up on the radar and turning into our bunks.

At reveille the following morning I was quite surprised to discover that we were tied up to a pier again, and even more surprised when I learned it was a pier at Norfolk Naval base, where I had left not too many hours before on a long train ride to Philadelphia. But this I passed off as just another example of Navy efficiency. The plan of the day here was the taking aboard of food supplies with an extra item—the repair of the S. U. radar. The solution to the radar troubles, we found was really very simple. It took only a Chief Machinists Mate, who had observed an S. U. being repaired, to suggest that we try changing the magnetron. This we did and the set worked perfectly. We were both relieved and embarrassed.

On November 19, the Canisteo left Norfolk—destination Bahrein, Arabia. This was what I had been looking forward to since the day of enlistment—travel, adventure, romance, etc. I soon found out, however, that there was a a great deal of work concerned in running a ship. The Canisteo, like most of the Service Force ships, was badly undermanned, and so Hays and I were forced into taking our share of the radar watches as well as maintaining it and all the other electronic equipment aboard. In the first few days, we became very well acquainted with the S. U. radar. At times the maintenance hours were almost as great as the operation hours. We became very proficient at trouble shooting. We were having more difficulty, however, in keeping control of our stomachs. The Atlantic was keeping it's reputation of being a rough sea, and the tanker, being empty, was riding the swells like a huge cork. I was advised not to miss the regular meals, if I was to avoid sea-sickness, so I ate heartily each time although generally with difficulty. Meanwhile Hays and I were watching each other to see who might have the first laugh. An incident during work on the radar decided that point. Hays had unwisely volunteered to go for a spare part which was needed at the moment. The spare parts were stored, in a disorderly fashion, many boxes deep in a rather small compartment. As is usually the case, the part needed was in a box near the bottom of the pile. A quick shift of a few boxes and a modified handstand, was the quickest way to the part. It also meant a quick trip to the rail for Hays where he lost one good navy meal and a little blood. I felt too sorry for him to laugh.

On November 24th, the ships orders were changed by radio. We were to go to Ras Tenura instead of Bahrein. The change was minor as both Bahrein and Ras Tenura are situated on the Persian gulf on the east side of Arabia. The complete trip was to take us through the Mediterranean, down through the Suez canal, the Red Sea, around the southern tip of Arabia, and up into the Persian Gulf.

On November 28th, Cape Trafalgar, near Gibralter became visable. This, according to Lt. Charles, a reservist on cruise who seemed to know history very well, was where the famous Admiral Nelson beat the combined French and Spanish fleets in 1805, getting himself thoroughly killed in the process. Lt. Charles, I might add, possessed a sparkling wit and good talent for writing. These he put to use, to the enjoyment of the whole crew, as feature writer for the "Oily Rag," the ship's newspaper. The "Oily Rag," whose slogan was "covers the Canisteo like the rust," featured news picked up by the radiomen, weather, occasional editorials by the Captain, "letters to the editor," and humorous articles by Charles, written mostly about the "goings on" around the ship. The "letters to the editor" were obviously also a product of the Charles wit. A typical letter, with answer, would read like this:

> Sir:
>
> I have suffered a nasty sprain of the wrist while strumming my guitar in the line of duty. How much convalescent leave may I expect when we reach the States?
>
> S—Purple Heart.

● College Engineering groups—large or small—are invited to visit the Allison POWERAMA in Indianapolis, Indiana.

What is it? The POWERAMA is a permanent exhibit which dramatically presents the story of pioneering and progress in power.

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Ans.:

Counting brig time of 3 months, I would judge about 90 days.

Needless to say, the paper was heartily enjoyed by the crew.

The plans were for a two day stop in Gibraltar. We entered the gulf of Algeceras and steamed in toward the "Rock." On the port side was the winter resort town of Algeciras and off to the starboard the "Rock" which has been the key to British control of the seaways for over 100 years. Two sidewheel tugs, which could have been refugees from the days of Mark Twain, escorted us to the quayside at Gibraltar Naval Base.

Since liberty for the crew was handed out on a two section basis, I was both surprised and happy to see my name on the shore patrol list for the first night. Here was an opportunity to go ashore two evenings instead of one. Six enlisted men and two officers made up the S. P. force, and our job, of course, was to keep the liberty section out of trouble. In order to accomplish this, it was necessary to go wherever the crew went—not at all a dull assignment. We, of course, anticipated no trouble from our own crew. After a rather brief sightseeing and souvenir buying tour, most of the crew were ready for the more interesting pursuits. I had been 9 days without so much as a cold beer for them. Gibraltar featured a wide variety of bars and nite clubs, the most popular spots being the Arizona bar and the "Wintergardens" dance hall. The greater part of the crew settled in the "Wintergardens" which featured ten lovely hostesses who danced and drank with the guests. The crew, in general, was behaving in a gentleman-like manner and this business of being a shore-patrolman seemed to be one of just watching them have a good time. This I found to be sadly untrue however, as on a routine check from the "Arizona" bar to the "Wintergardens," we stepped inside just in time to see "Flags," the big six foot signalman, down on all fours, peering delightedly up at one of the hostesses, pointing, and yelling, "Look!", "No skivvies!", "No skivvies!" Although the crew was enjoying the whole situation, the management was a little unhappy and insisted, rather strongly, that "Flags" leave. So we led him outside, convinced him he had had a few too many, and obtained a solemn promise from him that he would go back to the ship. It turned out that we were a bit too gullible however, entrusting him to go back, as approximately twenty minutes later we found "Flags" two blocks up the street in a big rhubarb with two husky British M. P.'s. It seems that "Flags" had been violating a local ordinance which forbids drinking in the streets and when the M. P.'s intervened, was loudly shouting his contempt for all the "dirty, yellow, limies." This time three of us went all the way to the ship with "Flags."

Liberty for the second section was granted after a stern lecture from the "exec," and passed without notable incident. On November 30th, we moved out of Gibraltar harbor in the middle of a roaring westerly gale. The rough weather didn't last, however, and soon it was smooth sailing in the Mediterranean with the crew once again settled down in the routine work of running the ship. Another edition of the "Oily Rag" was published and among the "letters to the editor" was the following:

Sir:

I would like to check a story I heard during our last liberty—are there still apes on the Rock of Gibraltar?

S—Nature Lover

Ans.:

According to the MAA's report, all hands returned on time and sailed with the ship as scheduled.

Also appearing was the following article:

Are we Asiatic or is this a sandstorm 160 miles at sea? First point not settled; but it is a sandstorm direct from the Sahara.

Radar indicates island of Malta still afloat to southward in spite of tough pasting from Axis bombers throughout World War II.

On December 7th, we arrived at Port Said. We stopped long enough to take aboard an English pilot, and, I suppose, make financial arrangements with the British. I was amazed to learn that there was a "slight" fee of $15,000 for passing through the canal empty and $75,000 for a ship with full cargo. But on the other hand, I could see how the digging of a ditch of that size might be rather expensive.

There were plenty of interesting sights along the Suez and cameras were kept busy. Huge bomb craters along the canal were reminders that there had recently been a bitter war fought here. Africa Corps prisoners were now busy repairing the canal banks. Camels—not really camels, but their one-humped cousins, the Dromedaries—were numerous. Arabs in their small fishing boats along the canal were quite indignant at being disturbed and one stood up shaking his fists at us after almost being capsized by the huge wake kicked up by our big bulging tanker. Top speed through the canal was supposedly 8 knots, which we observed only when passing the British check stations that appeared periodically along the "ditch." We passed through several small lakes, which the canal's builder, De Lesseps, had apparently taken advantage of to lessen the task of construction. An interesting observation of the design of the canal is the numerous bends which were purposly included to keep the tides from rushing through and washing away the banks.

After approximately 14 hours of canal travel, we entered the Gulf of Suez at the southern end of the "ditch." Here we dropped our English pilot and entered the Red Sea. Shortly we were sailing over the part of the Red Sea where the Israelites, of biblical history, crossed in their flight from Egypt. Visible on the eastern shore was Mt. Sinai, where Moses went up and came down with the Ten Commandments. Soon the Red Sea widened out and the Gulf of Akabah joined in. And here, once again according to Lt. Charles, is where King Solomon's Task Force sailed from Elath for Ophir when he was in quest of the Queen of Sheba. On December 10th, we passed through the straits at the southern end of the Red Sea. The straits are known as "Bab-el-mandeb," which is Arabic for "Gate of Tears." Here a lot of small craft have smashed up due to rocks and tricky currents.

On December 11th, Aden appeared on the port side. Aden, the historic gateway to the east, is situated on the edge of an extinct volcano. From Lt. Charles we learned that Aden was once the meeting and market place for East and West when overland trade routes were the only ones in business. Vasco DaGama put them out of business by sailing around the Cape of Good Hope and established the all-water route. The town died but came to life again when the Suez canal made it strategically important.

On December 12th, we see from the navigators charts that we are passing the Hejaz mountains which are 11,000 feet high and the highest in Arabia. Three days more sailing and we dropped "the hook" at Ras Tenura in the Persian Gulf. This port of our destination was anything but impressive. Other than the numerous oil derricks and tanks, the only thing visible was sand and more sand. Fortunate for the crew however, the skipper was a man with foresight and a great concern for the morale of his men. Almost immediately upon arrival, motor launches were put over the side, and a goodly quantity of beer from the ships refrigerators lowered into the boats. Although drinking in any form

is strictly forbidden aboard ship, there is no law against beer on the beach. So, joyously, swimming and fishing parties from the first liberty section were off in the motor launches, well supplied with beer. When the fishing parties returned, a few hours later, among their catch was a vicious looking barracuda. Liberty section number two gave up the idea of swimming.

The next day, we pulled alongside the pier to load 116,000 barrels of cargo oil and motor gas. Arabia had no trouble in sparing it. Geologists have estimated that there is 25,000,000,000 barrels of oil within a 50 mile radius of Ras Tenura. That figure is 2 billion more than the United States' total resources in all parts of the country. And this was just one of Arabia's fields. They have others just as large in other parts of the country.

On December 18th, with a full cargo of oil, we backed away from the pier and began the long trip home. Although the 80 degree temperature in December was very much enjoyed by most of the crew, none were particularly unhappy about laving Ras Tenura—which was now popularly known as "Horse-Manura." Shore leave, even had it not been strictly forbidden, was most unattractive here. The trip home, though over a route now familiar, was not of necessity a dull one. Christmas time found the ship in the Red Sea again, and the crew organized a Christmas show. Red Cross packages with turtle-neck sweaters were handed out as gifts. On December 27th, we entered the Suez canal again and by this time the turtle-neck sweaters were very much appreciated. Once into the Mediterannean we were reminded that it was still winter in the northern latitudes. On New Years day the Pillars of Hercules (Straits of Gibraltar) again came into view. Aboard the Canisteo, it was pay day—it's always pay day one day out of port and on January 2nd, the 99 was to drop the "hook" in Tangier Bay where the crew was to have its first good liberty in five weeks.

Tangier is an international city in Spanish Morocco. The population is made up mostly of Arab, African, and Spanish, although almost all nationalities seem to be represented. It was the popular opinion among the crew that the skipper had picked Tangier as the liberty port since it was an international city and utterly impossible for anyone to get into trouble there. This point, however, was questionable and I was very relieved when I checked the watch list and found that I did not have shore patrol duty. The liberty was what it might have been expected to be for a crew which had been at sea for five weeks.

On January 3rd, we began the last leg of the trip. Bad weather was expected. We found terrible weather. We were caught in a series of North Atlantic storms. Winds of 56 knots (62 m.p.h) whipped up 15 and 20 ft. waves. The Canisteo groaned and lurched through them. Our course was such that the 99 was taking an appreciable roll and even though I was no longer bothered with sea-sickness, I found it almost impossible to sleep in the new style rigid bunks which the ship had. Now I could appreciate the use of hammocks that sway with the ship rather than roll you over in bed. On the third day, the skipper ordered a change of course to ease the situation. Tankers are known to break in half in heavy seas such as this and it was the general opinion that for this reason the skipper ordered the change in course. We lost 15 miles that day. The next day found the wind subsiding somewhat, and so the Canisteo went back "on course." On January 14th, after 11 days of fighting the Atlantic, the 99 tied up at Norfolk Naval base again. Statistics for the complete trip indicated that the Canisteo had carried us over 20,555 miles of blue water in 50 days of sailing. Ship and crew were "saltier" by one two-month Arabian cruise.

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Richard J. Conway, Lehigh '51, selects Manufacturing Engineering at Worthington

RICHARD CONWAY checks cutting tool with machinist before milling a pump casing.

After completing his general training which brought him in contact with all departments, Richard J. Conway decided that manufacturing engineering was his field. He says, "I chose the Manufacturing Engineering Department after completing my general training at Worthington because as a graduate in Industrial Engineering I can learn the practical aspects of my field while applying theory I learned in college.

"The personnel of this department work together as a team toward the solution of the numerous problems which arise daily. We have the cooperation of all other departments in the corporation in getting the necessary facts pertinent to the solution of these problems. In the course of our day it may be necessary for us to meet the Plant Manager, Chief Engineer, Comptroller, several department heads, clerks, foremen, machinists and many others throughout the company.

"I have contributed to the solution of many problems handled by this department including metal spraying, machining procedures, purchasing new equipment and designating proper dimensions to obtain desired fits between mating parts.

"I enjoy my work because I'm doing the work I want and my formal education is being supplemented with practical knowledge gained from the tremendous wealth of knowledge available to me at Worthington. I know from personal contact with many other departments in the Corporation that Worthington can and will find their young engineers a spot which will give them the same opportunities as have been afforded me."

When you're thinking of a good job, think *high*—think *Worthington.*

FOR ADDITIONAL INFORMATION, see your College Placement Bureau or write to the Personnel and Training Department, Worthington Corporation, Harrison, N. J.

WORTHINGTON

The Sign of Value Around the World

Atomic Electric Power

A new reactor will designed, built, and operated by North American Aviation, Inc., as part of the Atmocic Energy Commission's program to develop competitive nuclear power, the company announced today.

This new reactor work will be jointly financed by North American and the Atomic Energy Commission. The entire project will cost about $10 million, including research and development. North American will assume $2.5 million of this cost. In addition the company will provide land for the reactor site, which is to be located near the company's present rocket engine field test laboratory in the Santa Susana Mountains just north of the greater Los Angeles area.

The reactor, called the SRE (Sodium Reactor Experiment) will be a "sodium-graphite" nuclear reactor generating 20,000 kilowatts of energy in the form of heat. This type reactor will operate at higher temperatures than do some other reactor types. This is expected to result in high over-all plant efficiency.

Because the most essential development problems are in the reactor and heat exchanger system rather than in turbines and other generating equipment, no electricity will be produced at this time. When fission occurs in the reactor, heat will be produced. This heat will be transferred to liquid sodium circulating through the "core" of the reactor where the fission takes place. The sodium will then be pumped to an exchanger where the heat will be removed. If electricity were to be produced, the heat would be used to make steam, which in turn would drive a turbo-generator.

While it is not difficult to produce electricity from atomic energy, a large amount of technical development is necessary to reduce the costs of the process. Economical electrical power from atomic enrgy depends upon the production of useful heat in a reactor at a cost comparable with the present methods using conventional fuels such as coal and oil.

Work with the SRE is expected to provide some of the detailed engineering experience and to develop some of the operational equipment needed to produce economical power. Several other avenues of study are being followed in the AEC's program to develop nuclear power technology.

The development of fuel elements and various combinations of fissionable materials for the reactor core will be an important part of the program. The reactor is slated to use uranium slightly enriched in Uranium 235 in the core. Studies can a'so be made with Thorium, and Uranium 233 in the core.

Characteristics of sodium which made it particularly suitable as reactor coolant are the metal's low neutron absorption qualities, good heat transfer properties, low melting point, and high boiling point. Use of sodium permits the production of the high temperature without high pressure.

The reactor, including the core and the cooling sodium, will be encased in a steel tank. This entire unit is to be installed underground, with five feet of dense concrete between the reactor and ground level.

Graphite, used to moderate or slow down the neutrons which cause the Uranium 235 to fission, will surround the fuel. The design calls for 10,000 gallons of sodium to flow through the core, and absorb the heat of the fission process.

Boron-steel control rods will regulate the fission rate of the reactor, and are to be moved by electric motors in and out of the core. Such rods control the fission process by absorbing neutrons. Safety elements will serve to stop fission and shut down the reactor when required.

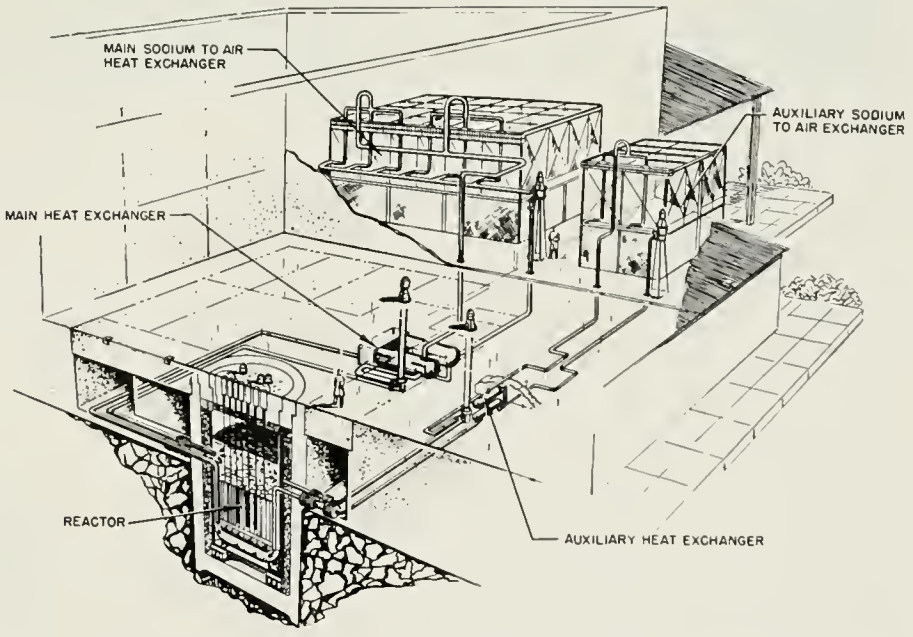
The sodium will be heated and pumped to a primary heat exchanger. Because the sodium coming directly from the reactor will be radioactive, this metal will give up its heat through a primary exchanger to another sodium circulation system. The second system will take the heat via uncontaminated sodium to a second exchanger where the heat ca nbe provided without the presence of radioactivity.

No fumes, gases, or other exhaust material will be emitted into the atmosphere, as the reactor will operate on a closed cycle system.

The reactor will be housed in a building about 100 feet long and 50 feet wide, with a 45 feet high bay area overhead. Including the connecting buildings, which will house machine shop, laboratory and office facilities, a total of about 20,000 square feet of covered floor area will be used for the SRE project. Only three technicians will be required to operate the reactor. Other engineers and scientists at the site will conduct various investigations and studies for the industrial power development program. Construction of the reactor is slated to begin shortly with completion expected in about two years.

Shortly after the end of World War II, North American began research and development work in the atomic energy field. Since 1948 the company has been engaged in reactor design and development work, together with associated projects, for the Atomic Energy Commission.

Within a few short years cheap electricity in the home and in industry will provide cheaper and better engineering materials.



This is the ortist's conception of the "sodium-grophite" nuclear reactor, soon to be built.

Which Sliderule?

by Don F. Kesler
E. E. '56

Do you jump when you hear the name of a slide rule? What does all that mumble jumble mean? To get to the log log duplex decitrig we have to start from the bottom and build up.

Mannheim Slide Rule

In 1859 a young lieutenant in the French army named Amedee Mannheim started playing with logarithms. He invented the slide rule that bears his name today. No wonder it has lasted so long. It is the basis and most used part of the slide rules of today. The front of the Mannheim rule has four scales, marked A and B, C and D, because that is their name. C and D are both simple logarithmic scales, one is on the stationary part and the other is on the slide next to it. They can be used for multiplying, dividing percentage ratio, and proportion problems.

If you ever forget how to use your slide rule, just try a simple problem like two times two. Slide the slide until the one on the C scale is over the two on the D scale. Now all the numbers on the D scale are multiplied by two. Slide the hairline to the number on the C scale you wish to multiply by two. The answer at the intersection of the hairline and the D scale. Now you can tackle a difficult problem.

The A and B scale are just like the C and D scale only there are two of them half as long placed side by side. Now we can get squares and square roots easily. Suppose you want to know the square of two. Set the indicator at two on the D scale and read where the hairline crosses scale A. On my slide rule there is a four, the square of two. If you want the square root instead of the square, you start by moving the hairline to the number on the A scale, and the square root will be on the D scale.

On the back of the slide are the S, T, and L scales. The S scale refers to the A and B scales. It gives you the sines and cosines. T refers to C and D and is the tangent and cotangent functions. The L scale gives you logarithms —set the number on the D scale, read its logarithms on scale L. Except for a few tricks and short cuts that is all there is to the Mannheim rule.

Poly Phase Slide Rule

A lot of things have been added to the slide rule in the last eighty years. The Polyphase Slide Rule is just a Mannheim rule with a couple of extra scales. The Polyphase has a CI and a K scale that the other one doesn't. CI stands for "C inverted"—it is just started from the other end. This may not sound like a lot of difference, but it makes a lot of difference in some problems. It lets us do multiplication of three factors with just one setting of the slide. It is very valuable in solving complex equations with long sequences of multiplication and division.

The K scale does the same thing for cubes and cube roots that A and B scales do for square figures. This is only the beginning of the simple problems you can do with your slide rule.

Polyphase Duplex Trig

The Polyphase Duplex Trig has many helpful advantages the polyphase rule does not have. The most important is multiplying by pi. Three new scales have been added and three old ones have been reveampd. The new scales are called CF, DF, and CIF. This means "C folded," "D folded," and "C inverted and folded." Notice that CF and DF are the same as C and D except that they are folded to begin and end with π or 3.1416. By a strange coincidence, every number on the D scale is automatically multiplied by π on scale DF. And oddly enough, every number on the DF scale is divided by π on the D scale.

In engineering calculations, π keeps bobbing up all the time. You'll be surprised to find out how convenient it is to have multiplications and divisions reduced to such child's play. Right here the CIF comes automatically. Like the CI scale it performs multiplication, division, or both with one setting of the slide.

The trig scales have been revamped beautifully. The advantage of this over the Polyphase and Mannheim rule is the lack of transferring numerical trig values. This is accomplished by all trig scales referring to the C and D scales. No more changing from the A to the D scale.

Polyphase Duplex Decitrig

The Polyphase Duplex Trig rule is made with a companion slide rule—the Polyphase Duplex Decitrig. The only difference being that the decitrig rule has its trig functions divided into degrees and fractions of a degree, instead of degrees and minutes and seconds. The main thing to be sure of is that you use the same graduations as the rest of the class.

Whoa, don't go out and buy a Polyphase Duplex Decitrig slide rule yet. While this is a good all purpose medium priced slide rule it is not the one for the earnest engineering student.

Log Log Duplex Decitrig

Just how would you go about getting the answer to the problem $5^{4.5}$? You could look in the log tables and find the log of five and multiply it by 4.5, then trace down the number whose log it is. You could borrow your roommate's Log Log Duplex Decitrig slide rule and get out the instruction book. Then set the index of scale C over 5 on the LL3 scale. Slide the indicator to the 4.5 on scale C and read where the hairline crosses the LL3 scale. The answer is 1400, and it still did not take as long as with the tables. Think how short it would have been if you didn't have to borrow the slide rule and use the instruction book. On a slide rule, $165^{6.38}$ is just as easy to calculate as 2^2.

Log Log Duplex Trig

As you can guess this is the same as the Log Log Duplex Decitrig, except that the trigonometry is graduated in degrees, minutes, and seconds.

An engineering student will be buying two slide rules if he buys one without the log log scales or if he buys a smaller slide rule than standard size. It may seem like a large initial investment, but it will save on your electric bill, scratch paper and pencil fund. With a slide rule you have a fair chance of finishing an hour exam in fifty minutes.

At least one truck, planned as a pilot model for the future, will be equipped with tubeless tires as an experiment, according to Fleet Owner, McGraw-Hill publication. In the larger sizes there still are problems to be solved, but increased production on passenger car tires is providing an incentive for satisfactory tubeless truck tires, too.

A certain student's interest in a girl is proportional to the cube of her chest expansion and inversely proportional to the square root of their distance apart. Find the approximate per cent increase in his interest if he moves 1% closer and simultaneously discovers she has puffed herself up 2%.

A Scotchman and an Irishman were on board a ship bound for Scotland.

Scotchman (catching sight of his fatherland): "Hurrah for Scotland."

Irishman (riled): "Hurrah, hell."

Scotchman: "That's right, every man for his own country."

Croesus' cavalry stampeding at the sight of Persian camels

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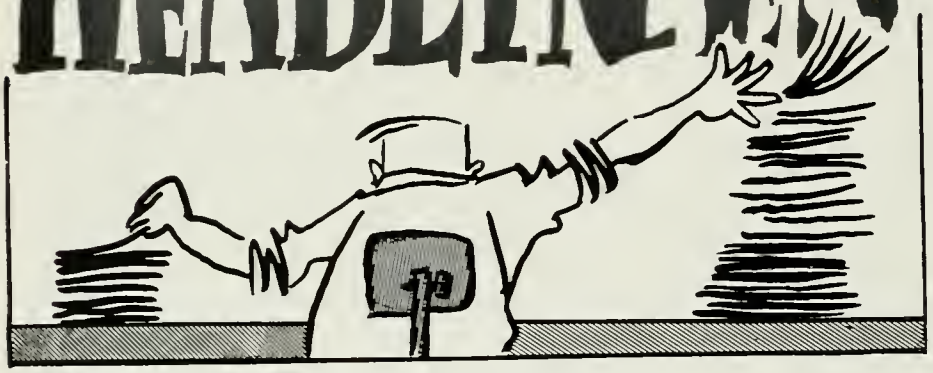

by Henry Lowenthal, M. E. '58

New Portable Radio-Phonograph

Majestic Radio & Television has announced the introduction of a truly portable radio-phonograph which will operate on self-contained batteries or house current.

Officials at Majestic explain that this is the first portable radio-phonograph made which incorporates a battery-operated phonograph motor utilizing a small battery pack containing inexpensive and easily obtainable standard B and A batteries.

Extremely lightweight and compact, the new unit weighs only 12 lbs., complete with batteries, measuring only 14" wide, 10" high, and 5" deep. The case itself is made of wood, luggage covered, and available in a choice of four colors including red, light tan, green, and brown. All of the plastic and metal parts are precision machined and tooled for extreme dependability and beauty of design. The leather luggage carrying handle makes it easy to carry from place to place.

The basic operations are controlled by a push-button keyboard with separate keys for on-off, radio, phonograph, and a current economizing adjustment which serves to prolong the life of the batteries. This last key serves a dual purpose in that it also provides extra volume.

The radio has a built-in ferrite stick antenna which provides excellent reception and selectivity. The unit also includes a relatively large radio dial whose inner diameter encompasses the ingenious rubber-rimmed turntable. The volume control can be used for radio or phonograph.

The crystal pickup and sapphire needle in the minature tone-arm provide excellent fidelity in connection with the large elliptical speaker. The drop-lid of the case conveniently holds a supply of records in place with an elastic cord.

The newest thing in portable radio phonographs.

New Office-Styled Coffee Vendor

An office-styled coffee bar vending machine that promises to become as standard as the water cooler has been introduced by the Bert Mills Corporation, St. Charles, Ill. The new coin-operated, automatic vendor, easily installed close to work, serves the beverage at any time according to the user's taste—with or without cream or sugar, with both, or plain. Use of the vendor by small firms will chop costly coffee break overtime since office workers no longer have to go outside for the beverage.

SUN-LOVING DOLLS

Dolls that will sunburn may be the next toy rage, according to Chemical Week, McGraw-Hill publication. A New Jersey laboratory has developed a doll that will tan when exposed to the sun and will revert to its original color when left indoors several hours.

TOO FRESH TO EAT?

In Copenhagen, live trout were anesthetized, shock-frozen at 40 below, stored for four months, defrosted, and placed in water, whereupon they were found to be alive and swimming. Food Engineering, McGraw-Hill publication, reports. Noting that the British accomplished the same type of experiment with warmblooded animals (hamsters),

The metal that makes time stand still

Thanks to chromium, steel now serves you with strength and beauty that lasts a lifetime

IN TIME, one of man's most useful materials—steel—is often the victim of such destructive forces as rust, corrosion, heat, or wear.

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the publication comments that it is fine for frozen fish and meat to be fresh—but not so fresh that it flops off the plate or walks across the table.

WELDING SPURS SHIPBUILDING

Progress in welding is largely responsible for the fact that the few shipyards in West Germany turned out vessels totalling 725,000 tons in 1953 as against an average production of 250,000 tons by German yards before the war, Welding Engineer, McGraw-Hill publication, reports. Among exhibits at the recent Cutting and Welding Exhibition in Essen were welded high-pressure steam boilers, seamless welded parts of steel bridges, welded gas containers and ship sections.

The unskilled operator can easily use this flaw catcher.

Flaw Catcher

A production gaging instrument that inspects four dimensions simultaneously on the carrier body of an automatic transmission is manufactured by The Sheffield Corporation, Dayton, Ohio.

In one quick operation, an unskilled operator can check the seat chamfer on the inside of the body, outside body diameter, over-all body length, and the dimensions from the top of the shank to the bottom edge of the upper flange.

Dimensional quality of the part is indicated by a master light and four individual signal lights on the diagram panel. When all of the dimensions are within tolerance, the master light remains white and the four signal lights on the panel black out. However, if one or more of the dimensions are out of tolerance, the master light turns red and the signal lights indicate the faulty dimensions by turning either red or green indicating respectively undersize or oversize. The lights of the correct dimensions black out.

Electronics Hobby Kit

The how's and why's of basic electronics are unfolded for youngsters in a new educational hobby kit manufactured by the Radio Corporation of America.

Youngsters can actually construct one and two-tube radio receivers and transmitters, chemical batteries, and experiment with sound and electricity from materials in the kit.

The electronics kit is the first in a series of such kits by RCA. Future kits will advance in detail until youngsters following the series will have a full-rounded knowledge of electronics.

A profusely illustrated book of instructions, prepared under the guidance of Encyclopedia Britannica, accompanies the kit.

Youngsters working from the first kit start by rubbing two pieces of paper together, thus inducing a flow of electrons. The electrons can be discovered and measured by the assembly of a galvanometer or current detector built from the contents of the kit.

Experiments with a head set allow youngsters to hear the electrons as they are produced.

By inserting strips of copper and zinc from the kit into ordinary lemon or salt water solution, the youngster then makes a chemical battery. He can use the battery to power a telegraph and can listen to the message with the earphone.

Additional experiments lead the youngster to the stage where he assembles and operates a simple low-powered radio transmitter. Finally, he can build the two-tube radio receiver and one-tube transmitter.

Contents of the kit include a variable timing condenser, plate coil, antenna coil, dial, "B" battery clip, ground clamp, 6-wire lead, coil antenna wire, screwdriver, coil magnet wire, steel rod, zinc strip, copper strip, compass, headphone and clamp, timing knob, mounting bracket, coil ground wire, and reversible assembly board.

Also included are two resistors, "A" battery clips, tube sockets, vacuum tubes; three capacitors; and one assortment of Fahnestock clips, screws, nuts, etc.

TV Set of 1964

General Electric scientists here envision the TV set of 1964 with a picture screen so thin that the complete unit could be hung like a painting on your living room wall. The circuitry would be built into the picture frame and would use printed wiring and miniaturized components. Controls would be located in a small box beside your easy chair.

Or for those who might prefer a table model, the thin picture screen would be mounted like a vanity mirror, attached to slender arms extending upright from a small oblong cabinet which would house the circuitry and controls.

These futuristic models, at least 10 years off, would receive color as well as monochrome pictures.

The POW, or "picture on the wall" TV receiver is just a glint in the scientists' eyes at the moment. But they are convinced such a unit can be developed and have designed a dummy receiver to help visualize the future TV unit.

As explained by Dr. Lloyd T. DeVore, manager of the G. E. Electronics Laboratory, the POW vision of the future stems from development work being done here on new minature electronic components, and from a complex project underway to speed the plotting of aircraft in military filter centers.

At present, this aircraft plotting, essential to successful interception of enemy planes, is done manually. The planes are followed by radar operators and information fed to plotters who pinpoint the planes with crayon on the transparent wall-size plotting board.

The plotting would be done automatically with the POW type of board.

Dr. DeVore says the radar display system under development will use elec-

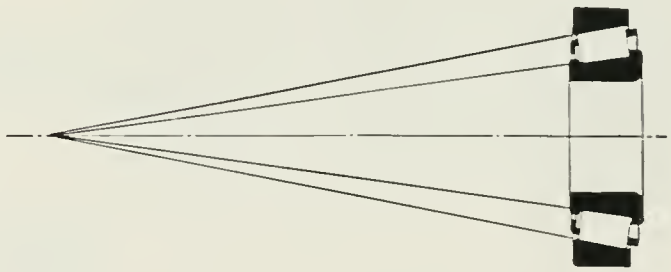
Another page for **YOUR BEARING NOTEBOOK**

How to design a freight car one man can push

You can make a big 55-ton freight car roll so easily one man can push it. How? By mounting its axles on Timken® tapered roller bearings. Timken bearings *roll* the load, eliminate the metal-to-metal sliding friction that makes old-style friction bearings start hard. They reduce starting resistance 88%. And, with Timken bearings, there's no danger of hot boxes —the major cause of freight train delays.

TIMKEN® bearings are designed to roll the load

As you see here, all lines drawn coincident with the working surfaces of a Timken bearing meet at a common point on the bearing axis. This means Timken bearings are designed to give true rolling motion. And, since they're tapered they can take radial and thrust loads in any combination.



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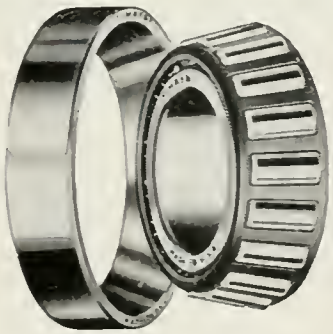

Want to learn more about bearings or job opportunities?

Some of the engineering problems you'll face after graduation will involve bearing applications. For help in learning more about bearings, write for the 270-page General Information Manual on Timken bearings. And for information about the excellent job opportunities at the Timken Company, write for a copy of "This Is Timken". The Timken Roller Bearing Company, Canton 6, Ohio.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◎ AND THRUST —◎— LOADS OR ANY COMBINATION ✳

tronic computer circuitry techniques to convert a transmitted signal into an image on the plotting board.

The plotting board screen will be composed of a space matrix constituted by closely spaced perpendicular wire grids luminescing at their intersections to reproduce the transmitted picture.

Development of speedier switching techniques and new fast-reacting electroluminescent phosphors are needed before the POW system could be applied to television receivers, Dr. DeVore said.

Fluorescent Lamp Life Tester

Scientists now almost instantly can predict approximately how long a particular fluorescent lamp will burn — something which formerly could be found out only by burning it until it blinked out after an average period of 7500 hours.

This was revealed by Richard N. Thayer, lamp development engineer for General Electric at Nela Park, Cleveland, in a paper on "Determinants of Fluorescent Lamp Life," presented at the National Technical Conference of the Illuminating Engineering Society.

Other things being equal, the life of a fluorescent lamp is proportional, according to Thayer, to the amount of a chemical called "emission coating," held by the lamp's cathode. By weighing this emission material, which serves as the source of electrons to carry the current through the lamp, the life of a lamp can be estimated.

The development engineer said his organization had developed a novel electronic method which permits rapid testing of fluorescent lamps for the quantity of chemical on their cathodes, but without breaking open or even lighting the tubes.

In this method, Thayer explained, the lamp under test is compared in an electronic circuit with a lamp having an uncoated cathode. When the current is applied, the coated cathode is slower to increase in temperature. This difference in resistance to heating is roughly proportional to the weight of the emission coating, and can be read on a meter.

The getting of the desired quantity of chemical on the cathode, and retaining it there through all lamp processing and handling steps, requires close controls, according to the G-E engineer. He said many checks are made to insure high quality. The new electronic tester is said to be an especially useful control tool in detecting short-life lamps.

The Rhino

The Rhino amphibious vehicle is the first vehicle which successfully traverses mud flats, marshes, rough terrain and also cruises in water, according to C. Alfred Campbell, vice president of Marmon-Herrington, builders of the Rhino.

"Every other amphibious vehicle we have evaluated over our many years of experience has trouble when it leaves the water and attempts to cross soft mud flats at the water's edge," said Mr. Campbell.

An idea conceived by inventor Elie P. Aghnides, the Rhino has been under construction and exhaustive test since 1948 by skilled engineers at Marmon-Herrington.

The new vehicle can negotiate swamps, soft mud, sand, climb 65 per cent grades, or travel down the highway at 45 m.p.h. With Hydrojet propulsion, the Rhino may be operated and maneuvered in deep water.

The first basic change in a thousand years in that great invention, the wheel, is responsible for the success of this vehicle.

The Rhino has a huge pair of hemispheroidal hollow spun aluminum wheels in front, plus a smaller pair in the rear. For highway operation, only a narrow rubber tread touches the road. In soft places, the traction area is increased with every inch of sinkage of the hemispheroidal wheels.

The Rhino is floated in deep water by the large hemispheroidal wheels and by its watertight body. Power and steering in the water are provided by a Hydrojet, making the Rhino so maneuverable in water that it turns easily in its own length.

Track laying vehicles usually are heavy and cumbersome, slow on hard surfaces, and unable to ford streams. The Rhino, even the present prototype version, will traverse paved roads, mud, swamp and water as required.

ASME SYMBOL AND MOTTO

The American Society of Mechanical Engineers has announced the names of winners in its contest to find a suitable symbol and motto for its 75th anniversary celebration in 1955.

Andrew T. Lemmens, design engineer with The Gleason Works, Rochester, New York, will receive $250 for his prize winning design. David H. Ray, retired mechanical engineer of North Tarrytown, New York, received the top award of $250 for his motto, "By Truth and by Service."

Mr. Lemmens' design combines a representation of the intersecting orbits of the atom—traditional symbol for nuclear power—with a representation of the thermodynamic cycle, by which heat is converted into energy and back again.

Carl Vrooman, icing tunnel group head, studies hot-air cyclic de-icing test on wing section of C-130 transport. The tunnel has a temperature range of —40° F. to +150° F. and maximum air speed of more than 270 mph.

New icing tunnel speeds thermodynamics research at Lockheed

Designed to meet a constantly increasing volume of thermodynamics work, Lockheed's new icing research tunnel now provides year 'round testing in meteorological environments normally found only in flight. It is the first icing research tunnel in private industry.

Lockheed thermodynamics scientists were formerly limited to testing time available at installations such as Mt. Washington. Now they are able to study in greater detail problems such as: thermal anti-icing; cyclic de-icing; various methods of ice removal; distribution of ice; rate of temperature changes in aircraft components; thermodynamic correlation between laboratory and flight testing; and development and calibration of special instrumentation.

C. H. Fish, design engineer assigned to the tunnel, measures impingement limits of ice on C-130 wing section. The tunnel has refrigeration capacity of 100 tons, provides icing conditions of 0 to 4 grams per cubic meter, droplet sizes from 5 to 1000 microns.

Thermodynamicist Ed Dean monitors main control panel in picture at left. Temperature, air speed, water flow rate, air pressure and other variables can be regulated independently.

B. L. Messinger, department head, analyzes test results with Thermodynamics Engineer E. F. Versaw, right, and Thermodynamicist Tom Sedgwick, left. The report was in their hands *only two days* after it was decided to conduct the test.

Career Opportunities at Lockheed

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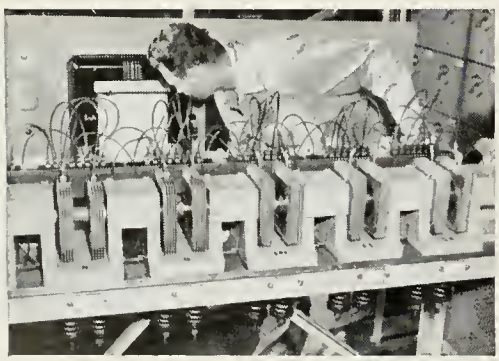
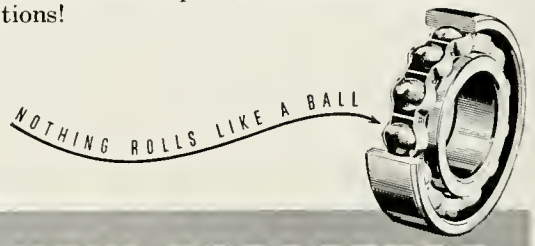
Such facilities are one of the many reasons why engineers and designers *call on New Departure* for assistance in **ball** bearing applications!



Reseorch at New Departure has been respansible for development of such devices as the Rockwell hardness tester and many forms of precision grinding and gauging equipment . . . such advances as the preloaded angular contact double row ball bearing and the self-sealed, lubricated-for-life ball bearing.



NEW DEPARTURE
BALL BEARINGS

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"Allis-Chalmers Graduate Training Course Gave me a head start"

says GERALD SMART

Marquette University, BS—1948
and now Supervisor of Plant Engineering,
Allis-Chalmers, Norwood, Ohio, Works

"MOST MEN graduating from college don't have a clear idea of what they want to do. These individuals are helped by Allis-Chalmers Graduate Training Course to find the right job whether it be in design, sales, engineering, research or manufacturing.

"My case is a little different, however. I started the course with all my interest centered on tool design and 'in-plant' service. The reason is that I started getting vocational guidance from some very helpful Allis-Chalmers men back in 1940."

Served Apprenticeship

"At their suggestion I had gone to school part time while working full time. This not only gave me the chance to serve an apprenticeship as a tool and die maker, and earn money, but I learned what I wanted to do after graduation.

"Then came the war and service in the Navy. After the war I finished school. By the time I started on the course in 1948, I knew what I liked and seemed best fitted to do. As a result, my entire time as a GTC student was spent in the shops.

"The 18 months spent in the foundry, erection floor and machine shop have all proved valuable background for my present job.

"As supervisor of plant engineering at the Norwood Works, I am concerned with such problems as: Plant layout, material handling equipment and methods, new construction, new production methods to be used in building motors, centrifugal pumps, and *Texrope* drives. It's an extremely interesting job.

"From my experience, I'd say, whether you're a freshman or a senior it will pay you to talk to an Allis-Chalmers representative now. You can't start planning your future too soon. And you can't plan starting at a better place, because Allis-Chalmers builds so many different products that you'll find any type of engineering activity you could possibly want right here."

Facts You Should Know About the ALLIS-CHALMERS Graduate Training Course

1. It's well established, having been started in 1904. A large percentage of the management group are graduates of the course

2. The course offers a maximum of 24 months' training. Length and type of training is individually planned.

3. The graduate engineer may choose the kind of work he wants to do: design, engineering, research, production, sales, erection, service, etc.

4. He may choose the kind of power, processing, specialized equipment or industrial apparatus with which he will work, such as: steam or hydraulic, turbogenerators, circuit breakers, unit substations, transformers, motors, control pumps, kilns, coolers, rod and ball mills, crushers, vibrating screens, rectifiers, induction and dielectric heaters, grain mills, sifters, etc.

5. He will have individual attention and guidance of experienced, helpful superiors in working out his training program.

6. The program has as its objective the right job for the right man. As he gets experience in different training locations he can alter his course of training to match changing interests.

For information watch for the Allis-Chalmers representative visiting your campus, or call an Allis-Chalmers district office, or write Graduate Training Section, Allis-Chalmers, Milwaukee 1, Wisc.

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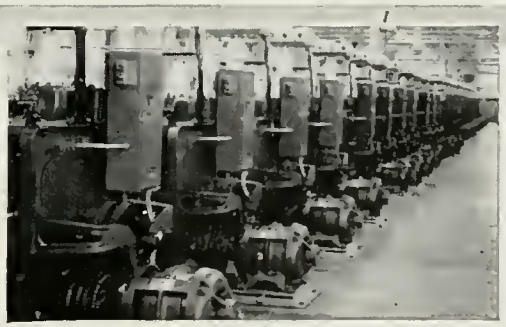

Motors, control, *Texrope* V-belt drives—all by Allis-Chalmers are used throughout industry.

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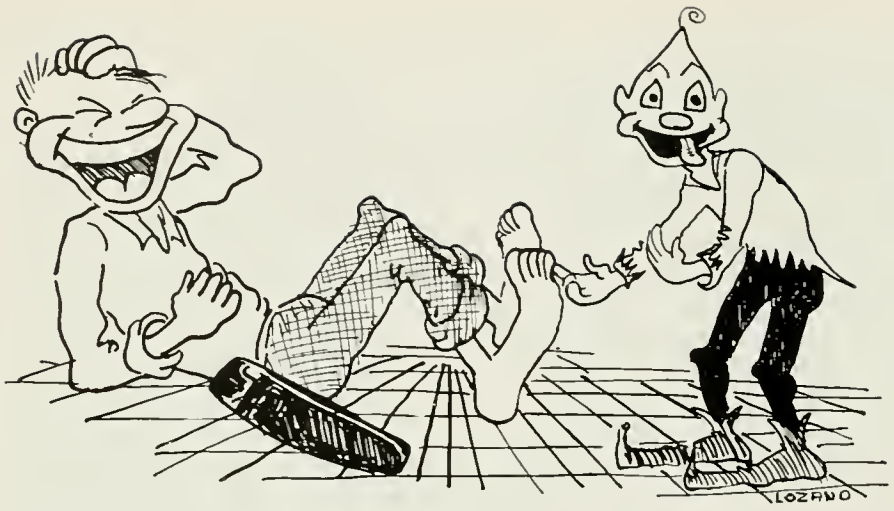


TECHNOCRACKS

"How did you get so completely intoxicated?" asked the judge.

"I got in the wrong company, your Honor. You see, there were four of us; I had a fifth of bourbon—and the other three didn't touch the stuff!"

* * *

Salesman: "Is your mother engaged?"
Little boy: "I think she's married."

* * *

Frosh: "Would you please repeat the question?"
Soph: "Beg pardon?"
Jr: "Huh?"
Sr: "Z-Z-Z-z-z-z."

* * *

Dr. Collins was lecturing: "I predict the end of the world in fifty million years."

"How many?" cried a frightened voice from the rear.

"Fifty million years."

"Oh," said the voice with a sigh of relief, "I thought you said fifteen million."

* * *

Engineer: "This new book on health says that bathing alone won't keep you healthy."

Coed: "Well, I don't care what it says, I'm going to keep right on bathing alone."

* * *

An inmate of a certain insane asylum, feeling that he had recovered enough to be released, appeared before the desk of the superintendent. After he was partially examined he was asked the following question:

Superintendent: "If we discharge you, will you promise to let women and liquor alone?"

Inmate: "Yes, sir."

Superintendent (beckoning a guard): "Lock him up; he's still crazy."

A dog and a cat became embroiled in a street corner fight, and a big crowd gathered to watch. One unruly spectator suddenly whipped a gun out of his pocket and shot the dog. A policeman heard the report and came running on the double. The killer threw his gun to the ground and appealed to the crowd. "Don't say a word to the cop. He'll think the cat did it."

* * *

College boy pouring drinks, "Say when."

College girl, "Right after this drink."

* * *

Ken: "What did the usherette say when her strap broke?"

Ray (always the straight man): "I dunno."

Ken: "I have two down in front."

* * *

Confuscius says, "Modern woman putting up such a false front, man never knows what he is up against."

* * *

A truck driver, hauling clay for a fill, backed his truck too far over the dump grade. The weight of the load being dumped lifted the front end of the truck several feet off the ground.

"Now, what are you going to do?" an associate asked.

The driver eased out of the cab and said, "I think I'll grease it—I'll never get a better chance."

* * *

"This model has a top speed of 130 miles an hour, and she'll stop on a dime."

"What happens after that?"

"A little putty knife comes out and scrapes you off the windshield."

* * *

You can tell that Americans trust in God by the way they drive.

Listen, my daughter, and you shall hear
The fate of the wife of an engineer.

Let my words be your solemn guide:
His slide rule is always by his side.

He'll stay with you, through sun or rain . . .
'Til St. Pat calls, and he's off again.

An electrical clutters your living-room floor
With radio carcasses by the score;

A civil may buy pearls and mink,
But he can't fix the kitchen sink;

Mechanicals have grease in their fingernails;
A chemical's kind, but lord, how he smells!

The dweller in halls with the shamrock above
May look attractive, but oh, spurn his love.

His love words are tender, his presence is fun,
'Til he speaks of the square root of minus one.

For he and his friends speak a tongue that's unknown,
And the company you keep will be largely your own.

* * *

Social Worker: "Sir, would you be interested in contributing something to the old ladies home?"

Spendthrift: "Sure, I'll send my mother-in-law over tomorrow."

* * *

But driver: "How old are you, little girl?"

Little girl: "If you don't mind, Buster, I'll pay full fare and keep the statistics to myself."

* * *

Med. Student: "I want to change the death certificate I gave you yesterday."

Professor: "What's wrong?"

Student: "I signed my own name in the space marked cause of death."

* * *

C.E.: "I have here the one and only cure for dandruff."

Date: "Really, how does it work?"

C.E.: "Oh, it's really simple—it's a mixture of alcohol and sand."

Date: "But, how does it cure dandruff?"

C.E.: "Well, you just rub the mixture on your hair; then the bugs get drunk and kill each other throwing rocks."

* * *

Where'd yawl git that Southern accent?

Honey-chile, I'se been drinking outen a Dixie Cup.

PHOTOGRAPHY AT WORK—No. 10 in a Kodak Series

Photography took a look

and a harvester got a stronger set of teeth

John Deere engineers, building a new beet harvester, wanted spring-tooth disposal wheels with long life. High-speed movies showed the way.

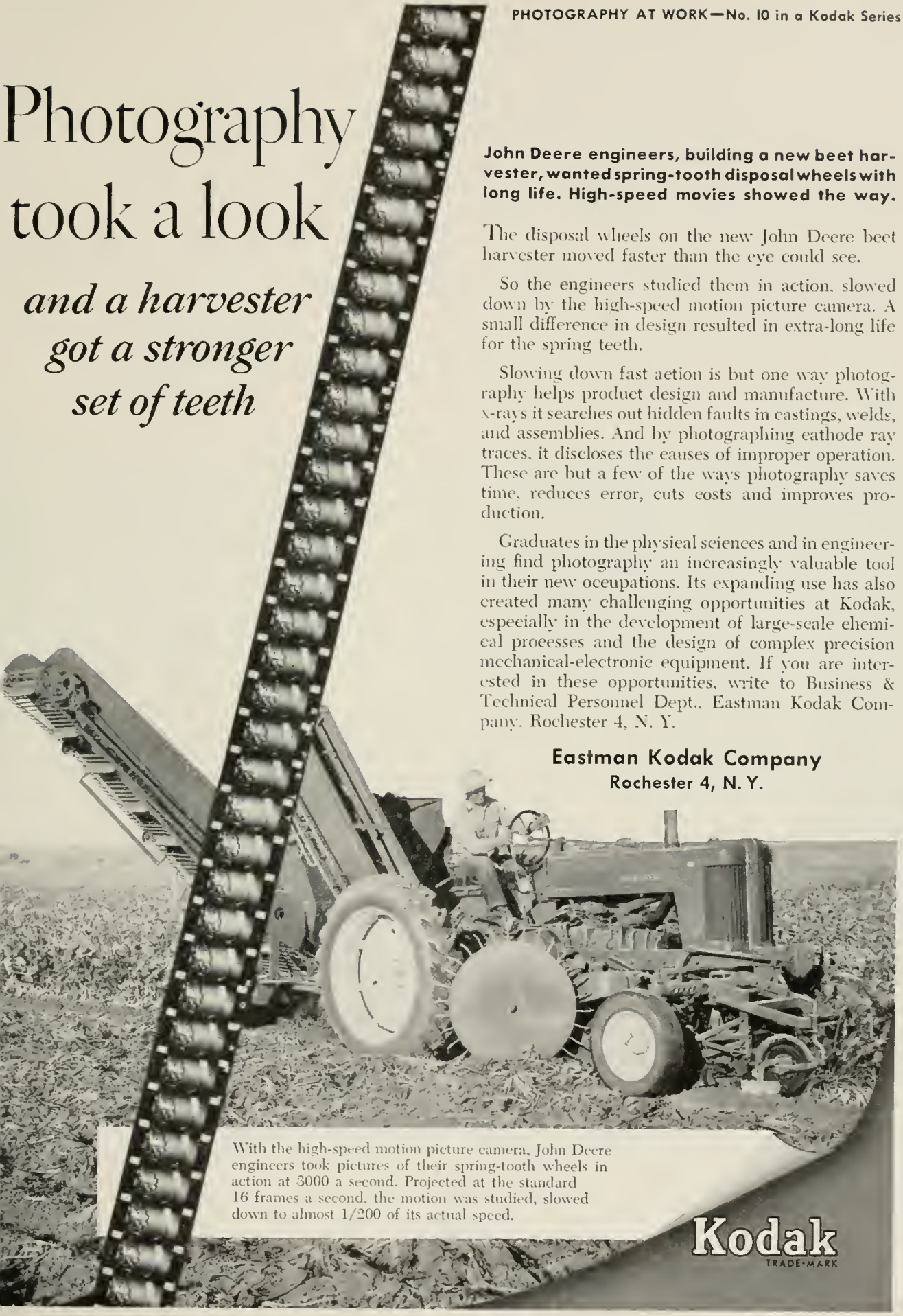
The disposal wheels on the new John Deere beet harvester moved faster than the eye could see.

So the engineers studied them in action, slowed down by the high-speed motion picture camera. A small difference in design resulted in extra-long life for the spring teeth.

Slowing down fast action is but one way photography helps product design and manufacture. With x-rays it searches out hidden faults in castings, welds, and assemblies. And by photographing cathode ray traces, it discloses the causes of improper operation. These are but a few of the ways photography saves time, reduces error, cuts costs and improves production.

Graduates in the physical sciences and in engineering find photography an increasingly valuable tool in their new occupations. Its expanding use has also created many challenging opportunities at Kodak, especially in the development of large-scale chemical processes and the design of complex precision mechanical-electronic equipment. If you are interested in these opportunities, write to Business & Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.

Eastman Kodak Company
Rochester 4, N. Y.



With the high-speed motion picture camera, John Deere engineers took pictures of their spring-tooth wheels in action at 3000 a second. Projected at the standard 16 frames a second, the motion was studied, slowed down to almost 1/200 of its actual speed.

Kodak
TRADE-MARK

LOOKING AHEAD WITH GENERAL ELECTRIC

In the next 10 years there will be more opportunity in the electrical industry than in all the 75 years since Edison invented his lamp

Chemistry Library
Noyes Laboratory
Urbana, Ill.

THREE quarters of a century after the beginning of the Age of Light, you might think that the Age of Opportunity in electricity had pretty well ended.

Exactly the opposite is true.

So many promising new ideas are now being developed that at General Electric we expect to produce more in the next ten years than in all the previous 75 years of our existence. Electronics, home appliances, the development of peacetime uses for atomic energy—these are only some of the fields where great progress will be made.

We know you will share in this progress whatever your career. Perhaps you will contribute to it.

Thomas Edison invented his electric light at age 32.

Progress Is Our Most Important Product

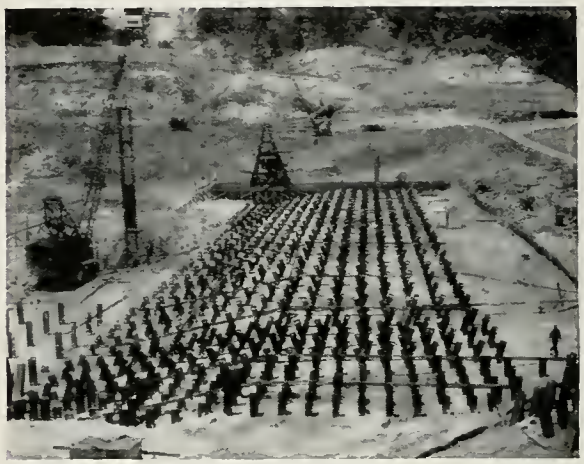
GENERAL ELECTRIC

ovember 25c

ILLINOIS TECHNOGRAPH

Only STEEL can do so many jobs so well

Famous Finger of Metal and stone pointing 1472 feet into the sky is The Empire State Building in New York City. This mightiest of buildings makes liberal use of Stainless Steel for both decorative and utilitarian purposes: in vertical strips beside the windows, in bands around the tower, in the two entrance corridors. "Maintenance?" said the assistant operating manager when asked about the exterior Stainless Steel. "What maintenance? We haven't touched the stainless steel since it was installed. And the condition of the steel is as good as ever." Not a bad record after more than 20 years.



Dragon's Teeth Sprouting? No, these are steel bearing piles in the foundation of a dam spillway. When the dam is finished, you'll never know the steel piles are there. But they'll be working just the same, for strength and safety, as enduring steel so often works unseen in buildings, highways, pipelines and power plants.

This Baby Sitter is Galvanized! In truth, a sturdy, good-looking Cyclone Fence is a dependable baby sitter. For it makes a safe home playground out of your yard. It keeps youngsters, absorbed in play, from stepping accidentally into the path of passing traffic. It prevents stray dogs from molesting your children or flowers. Cyclone Fence, made by U. S. Steel, is further evidence that only steel can do so many jobs so well.

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This trade-mark is your guide to quality steel

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If you're thinking about what you're going to do after graduation . . . if you're interested in a challenging, rewarding position with a progressive company . . . then it will pay you to look into the opportunities with United States Steel. Your placement director can give you more details, or we'll be glad to send you the informative booklet, "Paths of Opportunity." United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

UNITED STATES STEEL

For further information on any product mentioned in this advertisement, write United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

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HE'S STUDYING A GM TEXTBOOK

YES, ever since our first issue—*June-July 1953*—the *General Motors Engineering Journal* has been welcomed by engineering faculties and students alike as an excellent contemporary source book.

And we suggest, if you are not familiar with this latest of GM publications, that you check your college library.

But—this is not a "circulation advertisement" for the *Journal*.

We mention it here—because we think a glance through any issue will give you a pretty clear picture of the high standards and advanced viewpoints of our GM engineers. And of the intellectual climate they find in which to think and to work at GM.

Certainly such standards, such viewpoints—and such a climate—must be weighed among the assets of a GM career.

So, again, may we suggest you glance at the *Journal* (copies are supplied free to all faculty members and school librarians who request them). We hope it will inspire you to write us for another important GM publication—"The College Graduate and General Motors." And to think seriously of making yours a GM career.

GM Positions Now Available In These Fields:

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ELECTRICAL ENGINEERING
INDUSTRIAL ENGINEERING
CHEMICAL ENGINEERING

GENERAL MOTORS CORPORATION

Personnel Staff, Detroit 2, Michigan

William R. Parlett, Cornell '48, Sets Sights on Executive Sales Job

BILL PARLETT has learned that helpful engineering suggestions promote good customer relations.

"Within the next ten years", says William R. Parlett, young Worthington Sales Engineer, "many of the officers of the corporation, district office sales managers and top salesmen will be retired.

"Appreciating the fact that someone must fill these jobs, our management is striving to develop capable leadership among the younger men of the corporation.

"As a prospective Worthington Sales Engineer, I received several months of classroom instruction by works managers, top sales personnel and application engineers at all of the Worthington plants. The background I obtained was a sound basis for further development and learning gained in one of the product sales divisions and then in a district sales office. After obtaining sufficient product knowledge and sales training, I was ready to sell directly to industry. As more important sales assignments are available, I feel I will progress in proportion to my own development and sales performance.

"As a Worthington salesman I contact a class of trade with which it is a pleasure to do business. The company's reputation is a key to a welcome reception by my customers.

"I have found that with Worthington you have job satisfaction, adequate compensation, and unlimited opportunity."

When you're thinking of a good job, think *high*—think *Worthington.* 3.6

FOR ADDITIONAL INFORMATION, see your College Placement Bureau or write to the Personnel and Training Department, Worthington Corporation, Harrison, N. J.

WORTHINGTON

The Sign of Value Around the World

Pedestrians are Pedestrians

Have you ever driven a car down Wright street at noon? It is not safe over ten miles per hour. Pedestrians are walking down the middle of the street, crossing diagonally at the corner, and have absolutely no respect for either the motorist or their lives.

Everyone seems to be complaining about the cars on the campus, either for or against them, but the elimination of cars on the campus would not solve the problem of the pedestrian. The motorists are to be congratulated on not killing a pedestrian on Wright street between classes.

It seems obvious that the pedestrian will never learn until something drastic has happened. Urbana police department announced that it was giving tickets to pedestrians who walk across the street against the traffic light. It would be better to eliminate jaywalking now by enforcement than wait until someone is killed to start enforcing it. Everyone knows jaywalking is dangerous and no one would object to crossing at the intersection if everyone else did also. A few signs and enforcement at the beginning of every year would solve the problem of the Wright street hazard.

The removal of the traffic light at the corner of Mathews and Green streets seems to have caused another similar problem. Last year the student had a fair chance to cross the street, and the motorist did not have to watch quite as closely. A traffic light is still needed at this corner. Admittedly the street is narrow, however, it is wide enough for a two-way street. Another solution would be to make it one way going south all the way. The present system is not at all suited to the pedestrian.

We urge you to try your best to make our campus as safe as possible. This can not be attained until we eliminate jaywalking. Please don't be a walking accident.

D. F. K.

ENGINEERS

or

PHYSICS GRADUATES

To those interested in advanced academic study while associated with important research and development in industry, Hughes offers two separate practical programs:

HUGHES COOPERATIVE FELLOWSHIP PROGRAM

for Master of Science Degrees

A program to assist outstanding individuals in studying for the Master of Science Degree while employed in industry and making contributions to important military work. Open to students who will receive the B.S. degree in Electrical Engineering, Physics or Mechanical Engineering during the coming year, and to members of the Armed Services honorably discharged and holding such B.S. degrees.

Candidates must meet entrance requirements for advanced study at the University of California at Los Angeles or the University of Southern California. Participants will work full time during the summer in the Hughes Laboratories and 25 hours per week while pursuing a half-time schedule of graduate study at the university.

Salary is commensurate with the individual's ability and experience. Tuition, admission fees and books for university attendance are provided. Provision is made to assist in paying travel and moving expenses from outside Southern California.

HOW TO APPLY

for the Hughes Cooperative Fellowship Program: Address all correspondence to the Committee for Graduate Study

University of Southern California

University of California at Los Angeles

THE HOWARD HUGHES FELLOWSHIPS

in Science and Engineering

Eligible for these Fellowships are those who have completed one year of graduate study in physics or engineering. Successful candidates must qualify for graduate standing at the California Institute of Technology for study toward the degree of Doctor of Philosophy or post-doctoral work. Fellows may pursue graduate research in the fields of physics or engineering. During summers they will work full time in the Hughes Laboratories in association with scientists and engineers in their fields.

Each appointment is for twelve months and provides a cash award of not less than $2,000, a salary of not less than $2,500, and $1,500 for tuition and research expenses. A suitable adjustment is made when financial responsibilities of the Fellow might otherwise preclude participation in the program. For those coming from outside the Southern California area provision is made for moving and transportation expenses.

HOW TO APPLY

for the Howard Hughes Fellowships in Science and Engineering: Address all correspondence to the Howard Hughes Fellowship Committee

California Institute of Technology

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County, California

S. S. Marine Dow-Chem, first ship ever built specifically for the transportation of liquid chemicals.

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Newest link between Dow's important Texas Division and eastern terminals is the 18,000-ton chemical tanker, "Marine Dow-Chem". First ship ever designed and built to carry chemicals, this huge tanker has a capacity of 3,500,000 gallons, including special nickel-clad, heated tanks that safely carry 73% caustic soda solution. The "Marine Dow-Chem" made her maiden voyage in April, completing three years in the planning and building of the vessel.

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you can depend on DOW CHEMICALS

DOW

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THE ILLINOIS TECHNOGRAPH

volume 70 number 2

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our cover

A modern oil refinery. The picture is from an advertisement of The American Blower Company. Reprinted with the permission of The American Blower Company and Armstrong Cork Company.

our frontispiece

Holding one of the 20,000 blueprints needed in the design and construction of the Mandan refinery, an inspector surveys some of the complex facilities. (Courtesy of Standard Oil Co. of Indiana)

The Monarch at Mandan

by Jim Piechocki, Aero E. '56

Several eons ago, a huge inland sea occupied the regions now called the Dakotas, Montana, Saskatchewan, and Manitoba. As the ages wore on and the earth shifted and shaped its crust into wavy geological patterns, a huge underground basin was formed beneath layers of ever-moving strata. The caveman, the Indian, and the pioneer plotted these grassy slopes without ever dreaming that beneath their feet lay a vast area of approximately one hundred and thirty thousand square miles of reservoir stocked with what we call today crude oil. In 1907, a well drilled by the Great Northern Oil, Gas and Pipe Line Co. struck gas at 178 feet. Another well in 1910 hit crude at 1,954 feet. In 1912, two government geologists began intensive field work in the Dakota-Montana region and concluded with a report stating that the basin should hold oil. They labeled it the Williston, and the petroleum magnates of the East momentarily looked up from their prosperous work and cast a thoughtful glance at those rolling plains of the West. Spot drilling began, but the record of over 400 dry holes discouraged any extensive development. It was only a few years ago that things really started happening oil-wise at Williston. In February, 1951, the California Standard Oil Company opened the Virden field with a discovery well in southwestern Manitoba. On April 4, 1951, an Armeda Petroleum Corporation well, Clarence Iverson No. 1, struck oil at 11,630 feet. The rush was on. There are 445 successful wells in the United States section of the basin today. The main difficulty of the basin is one of finding a market. North Dakota wells, with a capacity of 200 barrels a day, have been slowed to 50 per day due to a lack of efficient, economical transportation. The answer to the problem lay in the building up of a large scale integrated industry within the state, and the construction of a refinery at Mandan, North Dakota, was one gigantic stride in the right direction.

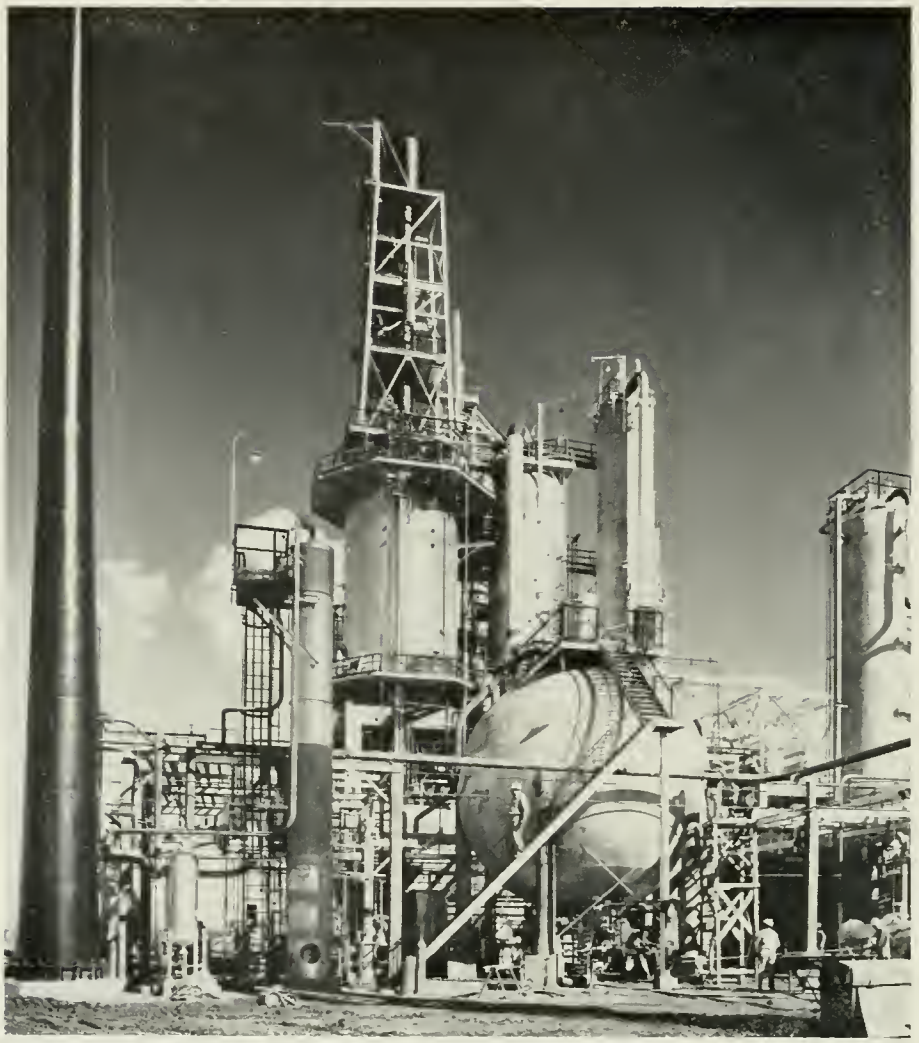
JIM PIECHOCKI

Jim is a newcomer to The Technograph staff on this campus. Heretofore he has periodically written articles for us from Novy Pier. We are hoping for more good work from him before he graduates in February of 1956.

Named for a tribe of Indians, the little town of Mandan was born in 1881 when the Northern Pacific Railway crossed the Missouri from Bismark, a somewhat larger settlement. Today Mandan boasts of a population of 8,000, the largest creamery in the United States, a modern foundry, a large cement-block factory, and a 600-barrel-a-day flour mill. Citizens are inherently proud of Fort Lincoln State Park which lies six miles to the south. It was from this fortress that a small band of troops under Colonel George A. Custer on May 17, 1876, rode out to round up a group of hostiles, never to return again. But engineers of Standard Oil did not consider the poignant historical aspects of Mandan in choosing this as a site for a refinery. They saw an abundant water supply in easy-to-reach Missouri River, they saw excellent transportation facilities present, and after considering many other aspects, topographical and otherwise, put their stamp of approval on Mandan. With the site chosen, the real work of design could be started. Desolate, grassy slopes were cleared, tractors chugged, locomotives hooted, trucks hurried about, whistles screamed and bells clanged—all for the coming of the king—the monarch of Mandan. Workers in distant fields paused to look upon the slowly rising and fanastic maze of pipes surrounding long and high towers that reached upwards, the sun reflecting brilliantly off the many spires that blazed like jewels in some royal headdress. This was the crown of the monarch.

The design of any refinery is keyed to the refining process itself, that is, it

Vapors piped off from different levels in the towering stills are cooled in the maze of heat exchangers seen in the foreground.



Towering fifteen stories high, this cracking unit processes 175 tons of fine clay particles in one gulp—enough to cover half the surface area of North Dakota. (All photos courtesy Standard Oil)

is a technique which governs location, layout, size, shape, and specific function of the components. The technique of refining, as any oil man will tell you, is extremely interesting. It consists basically of heating the raw crude to a high temperature and drawing off the vapors. The crude is a rather complex substance, and the components, obliging as they are, vaporize at different temperatures and will assume different heights when confined in the top of a disillation tower. Cooling recovers the vapors and they can now be piped off for further treatment. Early refiners generally produced three or four products; gasoline (naphtha), which was not very useful in the 1900's, kerosene, for which there was a very great demand, fuel oil, and sometimes coke. The first crude to be refined in this country had little sulfur content. It was called "sweet" crude because its by-products, especially kerosene, were pleasant enough to smell. But this was not the case with the oil discovered near Lima, Ohio, which was tagged as "skunk juice" or "polecat" oil because of the staggering, over-riped egg odor of its sulfur compounds. Herman Frasch, the famous German chemist, and William Burton of Standard Oil (Indiana) separately discovered the solution by passing the heated crude or kerosene over copper oxide. The sulfur in the oil reacted with the copper to form an insoluable copper sulfide, and people now bought Lima oil without fear of any dreaded odors. With the advent of automobile and the internal combustion engine, gasoline demands rose by leaps and bounds. The refinery techniques of the day did not produce enough naphthas to meet the needs. But along came William Burton again, this time with a process of heating the crude at great pressures, thereby halting rapid evaporation and "cracking" the larger molecules into the lighter, desperatly needed naptha particles. Further development resulted in the use of a catalyst in the cracking process. When the molecules formed are too small, they must be glued together again in another process called polymerization, which produced compounds which are not excessively volatile.

All these considerations play a dynamic role today in the design of a refinery. For example, present methods of distillation are adapted to produce a maximum of products. The reduced crude or remaining heavy residue usually requires a considerable amount of processing if it is not to be lost as waste. The Williston crude is of a high gravity and hence the reduced material needs no further purification at Mandan. After primary distillation, the reduced crude is introduced directly into a catalytic cracker, completely eliminating the necessity of separated units. Mandan is supplied with crude from a 156 mile pipeline from the northwest fields. The crude is desalted first and then piped to the crude distillation section where it is heated under pressure. The vapors separate and assume different levels in the top of the distillation tower. Light naphtha goes to the top, with heavy naptha right below. Kerosene and other fuel oils occupy the middle levels. From the lower part of the tower comes a gas-oil suitable for use in furnace oil. The crude residue occupying the bottom moves on to the integrated catalytic cracker which now produces wet gas and unstable gasoline in the top of this unit. From the three succeeding levels come light and medium cycle oils, which are used in blending into distillate fuels, and heavy cycle oil, most of which usually goes back into the cracker again. Light naphtha from the original distillation along with wet gas and unstable gasoline move to the vapor-recovery section. Two of the products at this stage are: a stabilized naphtha which is the basis for the gasolines, and wet gas which goes to the polymerization section which bonds the light molecules into a high-quality heavy naphtha.

At the Mandan refinery, these four process of distillation, catalytic cracking, vajor recovery, and polymerization, althought separated by about 300 feet for safety sake, are united physically. The crude distiller and catalytic cracker sections are back to back, with the pumps in a single pump house handling the high-temperature stocks between the two units. The vapor-recovery and polymerization sections are similarly orientated.

It would seem that this arrangement would require a minimum of storage tanks. But Standard Oil's engineers found this impractical because of the variety of the quality of products. Products of various qualities made to varying specification cannot be turned out unless there are tanks in which the constituents for each product can be stored for later use. However, the theoretical minimum was a starting point which brought the number of tanks to a practical minimum of 53 with a total capacity of 2,770,000 barrels. One very interesting fact con-

cerning refinery tanks is that they are gauged directly into barrels instead of, as is usual, feet and inches. This procedure eliminates the time consuming use of conversion tables and reduces gauging errors to a minimum.

The 156 mile distance to Mandan from Tioga to the northwest is spanned by a 12 and 16 inch crude oil pipe line. Construction on the pipeline began on June 15, 1953 and by Nov. 20, the line reached Mandan. At present, the pipeline handles 30,000 barrels a day but it was designed so that its capacity can be increased to 100,000 barrels a day by the addition of pumping stations. A relatively small amount of Mandan's products move by rail or by truck. An 18 spot railroad car loading rack is located near the southwest corner of the refinery, and the Northern Pacific Railroad provides a switching service. But most of Mandan's output travels in Standard's own pipeline to Moorehead, Minnesota. This 200-mile 10-inch line supplies gasoline, power fuel, kerosene, heater oil, furnace oil, and diesel fuel east to Minneapolis, and is slated to be the first of Standard's lines to use the new microwave communication system.

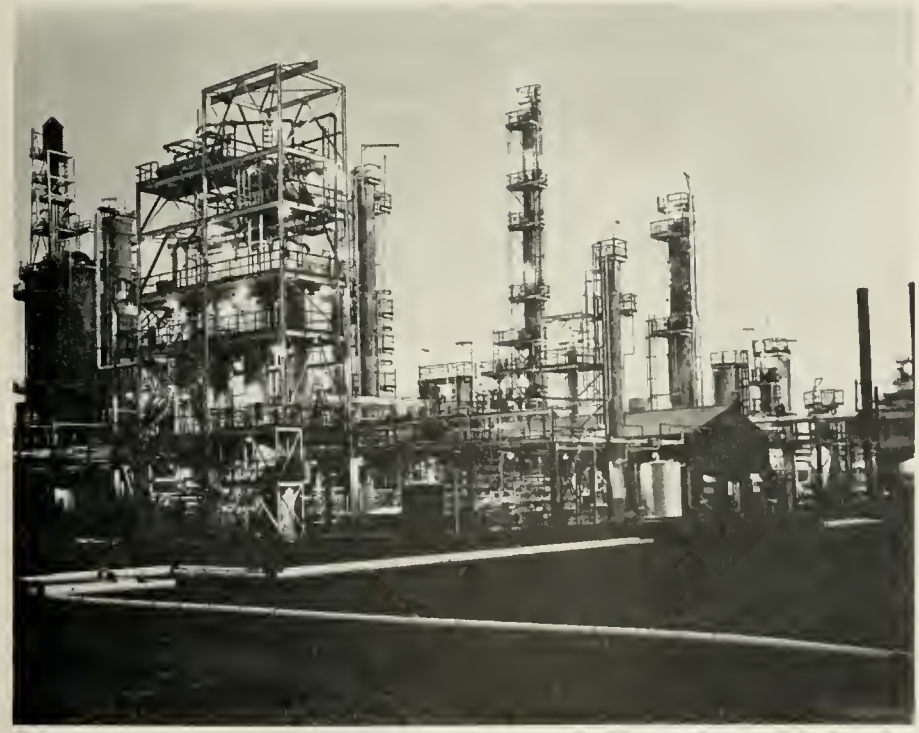
It was originally planned to design the Mandan refinery for a capacity of 15,000 barrels a day with provisions for eventual expansion to a figure of 30,000. Efficiency of operation and the expanding source of crude, however, dictated a revision even before the designs were drawn. Mandan is now set up for an initial capacity of 30,000 barrels a day, and all existing facilities are adapted for further expansion.

Three of Mandan's storage tanks frame the stately-looking 'cat cracker' against the North Dakota sky.

Mandan's Standard Oil refinery requires 15 million gallons of water a day at steady production. Actual consumption will be lower because the water within the refinery will be circulated over and over again. The refinery utilizes a new pumping station constructed adjacent to the existing water station for the city of Mandan. Six vertical-shaft submerged type turbine pumps are shared equally with the city. Raw Missouri River water is pumped continuously to a water treating plant within the refinery. A circular clarifier coagulates the remaining sediment. Coagulated overflow goes directly into the refinery's cooling tower. Drinking water is obtained from the Mandan city line.

The Mandan refinery is rather unique in many respects. There were 25,000 tons of steel used in construction of the refinery. Pipes in the refinery proper, if laid end to end, would stretch 56.8 miles. A total of 25,000,000 gallons of water circulate daily in the refinery. About 150 miles of electrical wiring transmits 120,000 kilowatt hours of electricity daily outstripping the city of Mandan itself. Concrete used in construction totaled 13,000 cubic yards. There were 20,000 blueprints drawn up for the design and construction job. The daily gasoline production could power 500 cars around the world.

The development of the Williston Basin, from the time early settlers jumped on saplings to stomp tools into the ground to Standard Oil's Mandan refinery is an ideal example of American ingenuity, creativeness, and development. The biography of Standard Oil is the history of oil, and the story of oil is the story of America.



This is the heart of the integrated units of distillation, catalytic cracking, vapor recovery, and polymerization. Intermediate storage is eliminated.

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Dielectric Breakdown Properties of . . .

THERMOSETTING LAMINATES

by N. A. Skow

Abstract

Thermosetting laminated plastics are used extensively for electrical insulation because of their unusual combination of electrical, mechanical, and chemical properties. Excellent electrical insulators, these materials are also mechanically strong, light in weight, and easy to fabricate. They resist chemical corrosion, moisture, aging, heat and temperature deterioration. To establish safe operating loads, tests for the endurance limits of dielectric strength were run on each of several grades of thermosetting plastic laminates plotting voltages against time. The data thus obtained indicate that for a given thickness and atmospheric condition, a maximum voltage exists below which failure will not occur. Tests of this type yield results which are valuable to the design engineer in determining the proper grade and thickness of material for use as insulating parts in electrical equipment.

Determining Insulating Properties

In selecting an electrical insulating material, the designer is primarily concerned with insulation resistance, dielectric loss and dielectric breakdown. The relative importance of these various properties depends on the application involved, but dielectric breakdown is almost always a major consideration.

As defined by ASTM, the dielectric strength of an insulating material is the maximum potential gradient that the material can withstand without rupture. It is difficult to evaluate quantitively because its magnitude varies with temperature, thickness of material, moisture content, and time exposed to stress. In general, the dielectric strength of insulating materials decreases with time of exposure to the electrical stress.

For a quick determination of dielectric strength, the short-time test has been devised. For fairly rapid determinations, but laying more emphasis on the time factor, the step-by-step test has been arranged. These tests involving short exposures are primarily comparative and are not indicative of the breakdown of the materials under prolonged exposure to lower stresses. The limitations of these tests already have been pointed out in the appendix to the ASTM Standards on Electrical Insulating Materials.

Since long service without breakdown is a primary requirement of electrical insulating materials, determination of the endurance limit is most essential. This can be measured by stressing the laminate with voltages less than the short-time value and recording the results at each voltage. When the maximum voltage that can be applied for an indefinite time without breakdown has been found, the endurance limit of dielectric strength has been established.

Differences between the dielectric breakdown properties of thermosetting laminates stressed parallel to laminations and those stressed perpendicular to laminations are sufficient to warrant investigation of behavior for each direction. The same dielectric strength and endurance characteristics do not exist where laminated sheets are used as insulating spacers (stressed perpendicular to lamination), and where laminates are used as terminal-board insulators (stressed parallel to lamination).

Grades of Plastics Tested

To obtain the results presented here, seven standard NEMA grades of laminated thermosetting plastics were tested: Grades X, XX, XXXP, LE, A, G-5 and N-1. Any other NEMA grade might be used in similar applications but those mentioned were selected because they are typical of the entire group. While this series of tests was made only upon laminates in the sheet form, the dielectric properties of tubes, rods, and molded parts are quite similar. Briefly, the materials tested can be described as follows:

Grades X, XX and XXXP are paper-base laminates bonded with phenolic resin. Grade X is intended primarily for mechanical applications and should be used with discretion under high-humidity conditions. Grade XX is made with a more absorbent paper and has a higher resin content than Grade X. Grade XX is better electrically, although slightly weaker mechanically, than Grade X. Grade XXXP, which has a still higher resin content, is one of the best electrical laminates produced. Grade LE has a cotton-fabric base and is bonded with phenolic resin. This grade is used on electrical applications requiring greater toughness than is provided by Grade XX.

Grade A is an asbestos paper-base laminate bonded with phenolic resin. It is more flame and heat resistant than the cellulosic grades. Bonded with melamine resin, Grade G-5 is a glass-base laminate with very high mechanical strength, excellent electrical properties under dry conditions and good heat, flame and arc resistance. Grade N-1 is a nylon-fabric base laminate bonded with phenolic resin. It has excellent electrical and mechanical properties even under high humidity conditions.

Program of Tests

Fig. 1 indicates the sample size and test arrangements used to determine dielectric strength and endurance limit of plastic laminates in both directions (perpendicular and parallel to laminations). For testing perpendicular to laminations, 6-x 6-in. samples were selected at random from standard production sheets (36x36x1/16 in.). For the tests parallel to laminations, specimens 2x3x½ in. were cut from standard sheets 36x36x½ in. A 0.2-in-diam hole was drilled along the 2-in. axis of each specimen to a depth of 1¾-in. The of each hole was counterbored with a flat bottom drill, leaving a ¼-in. thickness of laminate between the bottom of the hole and the edge of the sample. While this is not a standard test specimen it was found very convenient in this study because it eliminated the problem of flashover. (To have used a specimen 6x6 in. would have meant the production of a 6-in-thick sheet of laminate for each grade to be tested.)

Short-time dielectric strength measurements perpendicular to laminations were made on the 6x6x1/16-in. specimens in oil as specified in ASTM Standard D149-44. The samples to be tested were first dried in an oven at 220F for 1 hr then cooled in a desiccator for 16 hr at 73F. After conditioning, tests were made using five specimens of each grade.

Short-time dielectric strength measurements parallel to laminations were made on the 2x3x½-in. specimens in oil. Because of the thickness of sample, these test pieces were conditioned at 220F for 8 hr followed by 16 hr of

cooling in a desiccator at 73F. Five specimens of each grade were tested.

Results of Tests

Results of tests in both directions are given for Grades XX, XXP, and N-1 at temperatures from 65F to 256F. Breakdown voltage versus temperature curves are given for both perpendicular and parallel directions for each of the three grades tested. Two significant facts are readily apparent: (1) Short-time dielectric strengths parallel to laminations are lower than those perpendicular to laminations (with the exception of Grade XX at temperatures above 180F; and (2) the difference in dielectric strength versus temperature characteristics parallel to laminations are comparatively small.

Grade XXXP laminate has the highest dielectric strength perpendicular to laminations within the temperature range covered and the drop in breakdown voltages is very small between 90F and 180F. This gradual change in breakdown voltage up to 180F is of particular advantage when laminated plastic components are subjected to hot-spot temperatures in electronic equipment. It is evident that there is a rapid decrease in the breakdown voltage of even Grade XXXP as the temperature is increased further. The breakdown characteristics of the three grades parallel to laminations are more nearly equal. This indicates that it makes little difference in regard to short-time dielectric strength which of the three grades is selected for operation at temperatures within the range covered.

The data indicate that parallel to laminations Grade N-1, nylon-base laminate, has the most rapid decrease in dielectric strength (short-time) with temperature, while the breakdown voltages of Grade XX appear between these two extremes throughout the temperature range.

Data are presented to indicate the effect of sample thickness on the short-time dielectric strength measured in both directions. The dielectric strength of Grade XX plastics laminate measured perpendicular to lamination is 515 vpm at a ⅛-in. thickness or slightly more than half the magnitude for a 1/22-in. sample thickness. The dielectric strengths parallel to laminations, measured at five thicknesses ranging from 1/16 in. to ½ in., are very close for Grades X and XX with sample thicknesses greater than ⅛ in. The decrease in dielectric strength may be compared to the law of diminishing returns in that each additional thickness of laminate provides a smaller increase in the total dielectric breakdown voltage of the sample.

This shows the necessity for maintaining equal sample thicknesses for all tests to obtain results for the purpose of comparison. For measurements perpendicular to laminations throughout this testing program a thickness of 1/16 in. was selected because it is representative of the sheet thicknesses used in many electrical applications. A ¼-in. thickness was specified for testing parallel to laminations because thinner sections were more difficult to machine to uniform dielectric gaps.

Effects of Conditioning

To determine the effects of conditioning, the dielectric strength (short-time) of Grade XX laminate was measured in both directions for various combinations of time, temperature and moisture treatment. The results of these tests are given for each specified conditioning treatment. Conditioning for a maximum of 4 days for measurements perpendicular to laminations was sufficient, but 21 days were necessary to insure uniform moisture absorption for obtaining breakdown voltages parallel to laminations. Because dielectric strength varies widely with changes in conditioning treatment, considerable care was taken to standardize the sample conditioning prior to dielectric strength tests. One hour drying at 220F was selected for samples to be tested perpendicular to laminations because it provided the most reproducible results.

These samples were removed from the conditioning chamber, placed between the electrodes of the testing equipment and immersed in an oil bath. As far as possible, the samples of each grade of laminate were tested at 85, 70, 60, 55, 50, and 45 per cent of the short-time breakdown voltage measured previously. Voltage was applied at the rate of 10 kv/sec until the specified magnitude was reached and maintained until rupture occurred. The voltage applied and the time in minutes required for failure were then recorded.

Measurements parallel to laminations were made in oil with a metal pin and plate as electrodes. All samples were conditioned in an over for 8 hr at 220F and five specimens of each grade were tested for short-time dielectric strength in accordance with ASTM D149-44. Because of the ¼-in. thickness of the electrode gap, a longer conditioning period was necessary to insure uniform dryness.

The endurance limit of the dielectric strength parallel to laminations was determined by applying voltages at the rate of 10 kv/sec until 85, 70, 60, 55, 50 and 45 per cent of the short-time breakdown value was reached. After rupture occurred, the voltage and time for failure were recorded. For all tests, the samples and testing procedure were made as uniform as possible.

Endurance Limits

The endurance limits, perpendicular and parallel to laminations, for the seven grades of laminates tested are given. The dielectric strength of all grades in both directions decreases rapidly with time until it is approximately 60 to 70 per cent of the short-time dielectric strength. The curves show that the breakdown voltage, or upper limit of voltage gradient without rupture, gradually approaches a magnitude that is independent of time. The endurance limit of the material is considered approximately equal to the maximum dielectric strength which will not rupture after a 100-min exposure to stress. This assumption is based on tests on five samples which, after resisting breakdown for 100 min, continued to withstand the applied stresses for 18 hr.

Short-time dielectric strengths and endurance-limit values are compared in Table 4. In part A, where the seven grades of laminates are tested dry at 73F, the ratios (per cent) of endurance limits to short-time dielectric strength are tabulated (data from curves in Fig. 3) to indicate the relative characteristics of the seven grades. Grade A, asbestos-base plastic laminate has the lowest dielectric strength and endurance limit in either direction but is recommended in high-temperature applications because of its superior heat resistance. The six remaining grades tested are suitable for high-voltage applications, Grade XXXP having the highest breakdown voltages perpendicular to laminations and Grade N-1, the highest parallel to laminations.

Safety Factor

For dry specimens, the endurance limits (in either direction) of the seven standard grades of laminates tested vary from 49 to 84 per cent of the corresponding short-time dielectric strength. Therefore the designer can consider a safety factor of 3, based on the short-time test, to be sufficient. For Grades XX and XXXP exposed to high humidity and elevated temperatures, the percentage ratio of endurance limit to short-time dielectric strength ranges from 47 to 86 per cent (including both directions). Again, a safety factor of 3 should be satisfactory. In actual practice, a designer may expect to use equipment under highly humid conditions, yet available data on the laminates may be limited to short-time dielectric strength under dry conditions. In these cases, a safety factor of 6, as recommended by NEMA[3] may be necessary.

Conclusions

Conclusions drawn from these tests would indicate that for selecting thermosetting plastic laminates to be used as

a dielectric medium, it is important to know the temperature at which the equipment is to be operated, the atmospheric conditions to be encountered, the mechanical strain and the dielectric stress to be applied. If the equipment is used under dry conditions and the mechanical strength requirements are not severe, paper-base laminates are very satisfactory. If humid conditions are factors it would be advisable to use the more water-resistant paper-base grades such as Grade XXXP. Under dry conditions requiring high mechanical strength it may be necessary to use a fabric grade such as LE and under continuous humid conditions requiring high mechanical strength it may be necessary to use Grade N-1. If arc resistance is an important requirement Grade G-5 is indicated.

Acknowledgment—The tests described herein were conducted in the Research Laboratory of Synthance Corporation, Oaks, Pa.

[1]Published by American Society for Testing Materials, 1916 Race Street, Philadelphia, Pa.

[2]For a description of the NEMA grades not included here see "Standards for Laminated Thermosetting Products," publication No. LP1-1951.

[3]NEMA Standards for Laminated Thermosetting Products Publication No. 46-118, August, 1946, paragraph LP-64.

During a sidewalk interview in Amarillo, Texas, an announcer asked a woman: "What did your husband say when he proposed? She replied that he just said he loved her and wanted to marry her. "Didn't he do anything to back up his statement?" "Oh, yes," she replied brightly. "We have two sons."

* * *

A divinity student named Tweedle
Refused to accept his degree.
He didn't object to Tweedle,
But he hated to be Tweedle, D. D.

* * *

Little Audrey, mad as hell,
Pushed her sister in the well.
Said her mother, drawing water,
"Gee, it's hard to raise a daughter."

* * *

A lovely co-ed named Loretta
Loved wearing a very tight sweater;
Three reasons she had:
Keeping warm wasn't bad,
But the other reasons were better.

* * *

Secretary: But, Professor, isn't this the same exam you gave last year?

Professor: Yes, but I've changed the answers.

* * *

Then there was the wolf lounging in a New York hotel lobby as an attractive young lady passed by. When his standard come-on brought only a frigid glance he scarcasmed, "Pardon me. I thought you were my mother."

"I couldn't be," she replied. "I'm married."

A minister, preaching on the danger of compromise, was condemning the attitude of so many Christians who believe certain things concerning their faith, but in actual practice will say, "Yes, but . . ." At the climax of the sermon, he fairly shouted, "Yes, there are millions of Christians who are sliding straight to hell on their 'buts'."

* * *

Three deaf gentlemen were on a train bound for London. "What station is this?" inquired the first gentleman.

"Wembley," answered the guard.

"Heavens!" said the second. "I thought it was Thursday!"

"So am I," exclaimed the third. "Let's all have a drink."

* * *

"Doctor, my son has cholera, and the worst of it is, he admits he caught it from kissing the maid."

"Well, well. Young people do thoughtless things, don't they?"

"But doctor, I've been kissing the maid myself."

"Too bad."

"And what's more, I've been kissing my wife."

"What? Oh, my gosh! Now we'll all have it."

Our heroine bought a parrot from a pet store only to learn that it cursed every time it opened its mouth. She put up with it as long as she could, but finally one day she lost her patience. "If I ever hear you swearing again, I'll wring your neck," she declared. A few minutes later she remarked rather casually that it was a nice day. Whereupon the parrot promptly said, "It's a hell of a fine day." The lady immediately seized the parrot by his head and spun him around in the air until he was almost dead. "Now, then," she said. "It's a fine day, isn't it?" "Fine day!" exclaimed the parrot. "Where in hell were you when the cyclone struck?"

* * *

Judge: "I'm sorry, but I can't give you a marriage license until you have a properly filled out form."

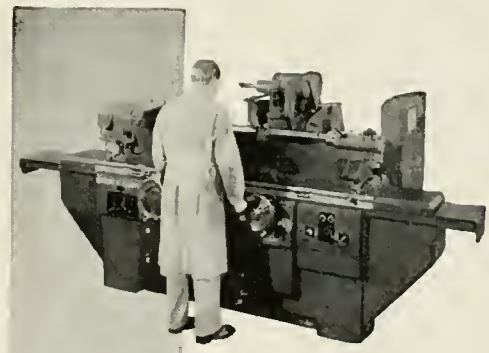
Coed: "Listen, if my boy friend does not care, why should you?"

* * *

"Was he fresh? Why, I had to slap him three times before I gave in!"

* * *

"When the eyes are closed the hearing becomes more acute," says a medical authority. "We have noticed several people experimenting in church."



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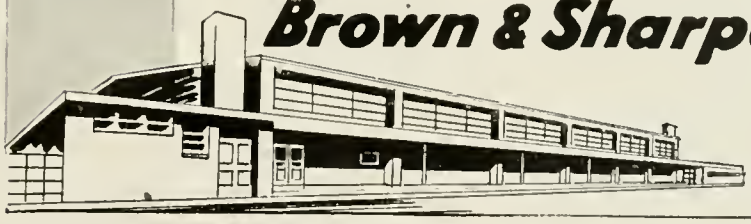

AIR POLLUTION

by J. H. Houdry, Vice President Oxy-Catalyst, Inc.

There is a new technique in engineering that promises to remove something old and troublesome from the air.

The something old in the air is pollution—tons and tons of contaminating particles, vapors and gases that for years have been pouring from our industrial plants, our power stations, our railroads, our incinerators, and above all our automobiles—noxious elements that threaten public health and impair the cleanliness of cities and industrial centers. This cumulative contamination of the air we breathe has been high-lighted recently in charges made by Los Angeles scientists that hydrocarbon contaminants in the atmosphere may be responsible for the marked increase of lung cancer in heavily polluted areas.

The new technique—very definitely an engineering approach to the problem—is a family of oxidizing catalysts developed by Eugene J. Houdry, pioneer almost twenty years ago in the catalytic cracking of petroleum.

To assign so sweeping a role to any one method of pollution control might seem presumptuous. But various types of oxidizing catalysts perfected by Mr. Houdry or now in development have indicated that they can burn at the source any gaseous or fine particulate matter that is combustible.

One type of oxidizing catalyst, called the Oxycat, is already offering a positive and economical solution to industrial plant pollution problems. The catalytic agent of this Oxycat is a platinum and alumina alloy that is coated onto a surface of porcelain rods.

After two years of study in various industrial installations the Oxycat has shown that it can:

1. Remove odors and visible smoke resulting from hydrocarbon exhausts—and also eliminate carbon monoxide.

2. In many cases generate usable heat in the process—enough to cut the plant fuel bill of one user by 90%—enough to return $27,500 yearly on a $25,000 investment for another company.

3. Turn waste gases into usable power—in one case to run a gas turbine.

4. Indirectly improve production processes and products in some applications and

5. Increase safety and reduce fire hazard in others.

In a typical case, that of the Radio Corporation of America plant in Camden, N. J., the Oxycat ended a localized but intense inplant pollution problem.

Plagued by an irritating wax smoke that blew into its office building from a nearby exhaust stack, RCA installed a bed of Oxycats to oxidize the smoke at its source—a burn-off oven in the company's powdered metals division.

In making powdered metal parts, RCA uses a wax binder to hold the parts together before final pressing. But after pressure molding and before the parts can be sintered, the wax binder must be driven off.

In doing this in a burn-off oven, RCA had been driving out to the air a mixture of wax particles and vapor—a smoke with an odor of burnt cork—very annoying to breathe.

The company first considered various methods of eliminating the wax smoke. The exhaust could be collected, condensed, filtered or burned. It was decided that some method of burning would give the most positive results with a minimum of maintenance and operating headaches.

Burning, in the ordinary sense of direct ignition of the fumes, would have been costly. A large volume of fume-air mixture (1400 cubic feet per minute) would have to be brought up to an ignition temperature of 2000 degrees or more. This in turn would require a high fuel consumption, a large combustion chamber and elaborate insulation and stack construction to withstand high temperatures.

RCA turned to catalytic oxidation—a method for burning the wax smoke at temperatures well below the normal ignition point. The company installed a bed of 204 Oxycats above its burn off oven.

Each Oxycat unit is a cake-like structure of 73 porcelain rods held together by two square porcelain end-plates and a porcelain spacer bar. The surfaces of these rods—tear-drop shaped to minimize back pressure—are coated with the catalytic agent—platinum and aluminum alloy.

The Oxycats are stacked side-by-side and one on top of the other on a simple grate in the exhaust stack of the Oven. The waste gases flow across the Oxycat rods. At the coated surfaces of these rods a catalytic reaction takes place, oxidizing the exhaust to a harmless effluent of carbon dioxide and water vapor.

(The catalytic agent of the Oxycat here acts to stimulate the oxidation reaction, to permit oxidation at temperatures far below the normal ignition point of the combustibles. Contrary to classical theory on catalysis which holds that the catalyst takes no active part in a reaction, Mr. Houdry has found strong evidence to corroborate the theory that a catalyst definitely does take part in a reaction, repeatedly entering and leaving, later returning to its original state when the reaction is completed.)

The oxidizing temperature of the Oxycat is about 500 degrees F. Since the wax fumes leave the burn-off oven at about 300, RCA installed a preheat burner to raise temperature to the desired point. The catalyst in oxidizing the preheated fumes raises exhaust temperatures another 50-100 degrees—a relatively small increase in this case due to the low concentration of the contaminants. Operation to date has shown complete elimination of the wax smoke.

The catalyst also eliminated explosive pockets of fumes that previously had a tendency to collect above the oven. At the same time the slow build-up of wax deposits in the oven stack was stopped. This build-up would obstruct air movement through the oven, gradually changing oven conditions. Now RCA can more easily obtain uniform operating conditions and maintain consistently high quality production.

RCA has mounted both the preheat chamber and catalyst housing above the burn-off oven on a steel platform nine feet above the floor. The compact installation minimizes the travel distance of the wax fumes and prevents the accumulation of wax in the ductwork.

The catalyst units sit one foot deep in an insulated chamber 42 inches square. An additional 18 inches of depth provides inspection area. The insulated combustion chamber is 90 inches long, 42 inches wide, and 42 inches deep.

Profitable Heat Recovery

A good example of pollution control that really pays is the Oxycat installation at the enameling plant of Enamelstrip Corp., Allentown, Pa. Installed more than two years ago—in fact the very first installation by Oxy-Catalyst, Inc.—a total of 1200 Oxycats have curbed a serious community problem for Enamelstrip and in the bargain have generated enough usable heat energy to cut plant fuel bills by 90 per cent.

Enamelstrip runs four metal coating lines—processes in which enamel and lacquer coatings are tolled onto continuous metal coil, then baked dry in an oven. These ovens had been driving off as many as 30 drums of xylene and toluol solvents a day into the neighboring community. The company's public relations problem with the neighbors, needless to say, was an acute one.

Typical catalyst operation at Enamelstrip can best be described in one of the company's two largest coating lines.

James B. Walker received his B.S. in mechanical engineering from North Carolina State College in June 1954, and he's presently working for his M.S. at the same college. By asking pertinent questions, Jim is making sure that the position he finally accepts will be the right one for a fellow with his training.

Jim Walker asks:

Can a mechanical engineer make real progress in a chemical firm?

H. M. Pickering, Jr., received a B.S. in M.E. and E.E. from the Univ. of Minn. in 1940. He gained valuable technical experience at Hanford Works, in Richland, Washington, and in Du Pont's Fabrics and Finishes Plant at Parlin, N. J. Today he is Works Engineer for Du Pont's Seaford, Del., plant, where nylon comes from.

"Pick" Pickering answers:

Well, Jim, that's what the lawyers call a leading question, and the answer leads right into my bailiwick. I came to Du Pont in 1940, after taking a combined mechanical and electrical engineering course. So I had what you might call a double reason for wondering about my future with a chemical firm.

I soon learned that the success of a large-scale chemical process is vitally dependent upon mechanical equipment. And the success of this mechanical equipment—especially for a new process—depends on (1) Research, (2) Development, (3) Plant Engineering, and (4) close Supervision. The net result is that a mechanical engineer at Du Pont can progress along any one of these four broad highways to a top-level position.

My own Du Pont experience includes mechanical engineering work in fields as varied as atomic energy, fabrics and finishes, and nylon manufacture. Every one of these brought with it a new set of challenging problems in construction, instrumentation, and power supply; and every one provided the sort of opportunities a man gets in a pioneering industry.

So, to answer your question, Jim, a mechanical engineer certainly has plenty of chances to get somewhere with a chemical company like Du Pont!

Want to know more about working with Du Pont? Send for a free copy of "Mechanical Engineers at Du Pont." This 24-page booklet describes in detail the four broad categories of jobs mentioned by "Pick" Pickering. Typical pioneering problems in each of these four categories are outlined. This booklet briefs a young mechanical engineer on how some of the newest and most challenging problems in his field were solved. Write to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Bldg., Wilmington, Del.

DU PONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

WATCH "CAVALCADE OF AMERICA" ON TELEVISION

Each can coat up to 50 tons of stock a day and exhausts 6800 cubic feet per minute of air-solvent mixture. Temperatures range from 300 to 600 degrees.

Because the oven exhaust is sometimes below 500 degrees (the oxidizing temperature of the Oxycat) a preheat burner has been installed to raise stream temperature at the start of a production run if necessary. The hot solvent fumes next strike the catalyst bed (814 Oxycats in this case) and are immediately oxidized to a harmless vapor.

Stack temperatures above the catalyst then rise to as high as 1400 degrees F. The preheat burner is automatically shut off—since there are enough combustibles in the gases to make the catalyst bed self-sustaining. The main gas burners are also shut off since Enamelstrip can then recirculate catalyst heat to run its ovens.

The plant has enough heat left over to supply other processes and when steam coils are installed over the catalyst bed will have enough energy for general plant heating needs. Even then the company will be throwing most of its catalyst heat away.

Enamelstrip gets another cost-saving bonus in the form of increased production. The company had been operating its ovens to the full capacity of the burners. With unlimited catalyst heat it has now doubled coating speeds and plans to double them again.

Power Generation, Too

Pollution control was not the problem when the Sun Oil Company installed $25,000 worth of catalysts to consume waste cat cracker gases. The objective was heat recovery and power generation.

Sun uses a different Houdry catalyst —in pellet form—to crack crude oil into high-octane gasoline at its Marcus Hook, Pa., refinery. During each cracking cycle the catalyst pellets becme coated with tarry hydrocarbons.

In regenerating the catalyst (burning these hydrocarbons off with hot air) a large volume of waste gases (carbon monoxide and hydrocarbons) is generated. Sun now runs these gases through a catalytic bed, generates 7,500,000 Btu per hour of usable energy.

Most of this heat is picked up in molten salt pickup tubes in the catalyst chamber and is used to generate process steam. The remainder of the energy in the gases is fed to a gas turbine that powers a turbo-compressor.

With the Oxycat installation complete on only one-half of this particular cracking plant, Sun was recovering $27,500 worth of previously wasted energy a year.

When installation is completed on this unit, annual savings should jump to $80,000.

Refinery-wide savings when all Sun crackers are catalyst-equipped are expected to reach $500,000 a year. And should the Oxycat be applied to all cracking plants throughout the country, the potential recovery of waste heat energy would be the equivalent of 10,000,000 barrels of fuel oil a year.

Coffee-Odors, Engine Smells

Still another use for the Oxycat is the removal of coffee odors. An installatoin on the roof-top of the coffee-roasting plant of Eppens, Smith Co., New York has shown that the Oxycat can completely end the odor problem.

This catalyst has also shown that it can reform smoky incinerators—completely removing visible smoke, odors and organic particles.

A major use for the Houdry catalyst —in fact its first use—is in a catalytic muffler for control of industrial truck exhausts.

A typical user, Land o' Lakes Creameries, Inc., reports that it uses four such units to permit mechanization of handling operations in its basement storage area—a confined, unventilated room 90 by 120 feet with a nine-foot ceiling.

When Land o' Lakes first tried to run a gas-powered truck in this area the fumes proved too much for the operator. The company now operates four catalyst-equipped trucks in the same area with no harmful effects. As in industrial installations, the catalytic muffler burns the noxious engine fumes to harmless carbon dioxide and water vapor.

This first type of catalytic exhaust was applicable only to engines running on unleaded gasoline or on LP gas. A modification of this muffler has been developed for 4-cycle diesel engines and is now being adapted to 2-cycle diesels. Mr. Houdry has also developed a catalytic exhaust for leaded gasoline—for automobile use—but this unit uses an entirely different type of catalyst.

A Versatile Instrument

The basic chemistry of the Oxycat indicates a wide range of uses. The Oxycat will burn just about any vapor or gas that can be oxidized—and do it at temperatures that are lower and hence less costly than direct flame incineration.

In actual practice, the Oxycat seems to do its best job on fumes that can be oxidized to either CO_2 or H_2O or both. That includes the entire family of hydrocarbons, as well as carbon monoxide —prime industrial causes of air contamination.

The Oxycat will function successfully over a wide range of inlet temperatures and concentrations—from gas streams near the explosive limit to those with concentrations of parts per million of contaminants.

Inlet temperatures—the temperature of the gases entering the catalyst—can range from room temperature or less up to 1500 degrees F. or more. In some cases pre-heating of the gases may be necessary—depending on the actual inlet temperature and the concentration of the pollutants.

If the gases are above 500 degrees (the oxidizing point of the catalyst) and are rich in combustibles probably no pre-heat will be needed.

If the gases are rich in combustibles but below 500 degrees some pre-heat will be needed at start-up only.

If concentration of combustibles is not high enough to maintain catalyst temperature above 500 degrees, continuous pre-heat will be needed. In general, the Oxycat will raise stack temperature 55 degrees F. for every Btu per cubic foot of dry exhaust gas passing over the bed.

All such factors of design must be determined by competent engineering analysis.

Prospect of Unlimited Life

As yet no definite limit has been set to the useful life of the Oxycat. Under most stack conditions it is expected that the catalyst will last for many years without appreciable drop in activity.

Basis for this conclusion is a test conducted on catalysts initially installed at the Sun Oil Marcus Hook refinery almost two years ago. Tests showed that after 8500 hours of continuous operation, these catalysts eliminated 99.2 per cent of the combustible material in the waste gases—exactly the same percentage as in June, 1952, when the catalytic heat recovery unit first went on stream.

These results were most significant since all previously known combustion catalysts have declined steadily in efficiency during operation.

Operating conditions at Marcus Hook were severe. In addition to light hydrocarbons, carbon monoxide and sulphur, the waste gases from the cat cracker contained abrasive dust (from the petroleum catalyst) and heavy tarry materials. The catalyst was also subjected to continued thermal shock. The temperature of the waste gases jumps 500 degrees—from 800 to 1300—and back again every 10 minutes.

The findings at the Sun Oil Co., were later corroborated by the Research Institute of Temple University, in tests of the original Oxycats installed at Enamelstrip Corp. Temple scientists reported that after 18 months of operation those Oxycats were eliminating 99.6 per cent or more of solvent pollutants.

A MESSAGE TO
COLLEGE ENGINEERING
STUDENTS

from J. M. Wallace, Manager. Meter Div.,
Westinghouse Electric Corporation
University of Pittsburgh, 1935

To the man who wants more than a job

You and I know that getting a job is not a problem these days. Industry needs thousands of young engineers.

But the man who wants more than a job might well pause and consider just how he is going to find his special opportunity. It cannot be found everywhere.

The man I'm talking about wants interesting work with a future, yes—but also something more. He is determined to help make the world a better place in which to live—and wants a job that will enable him to do this. He is co-operative in his work, but demands the dignity of being treated as an individual. This man had high purpose when he elected a career as an engineer.

I know this man. He's many men at Westinghouse. He's an engineer's engineer.

You, who want more than a job, are this man, too. You will be among your own at Westinghouse. G-10273

YOU CAN BE **SURE**...IF IT'S
Westinghouse

For information on career opportunities with Westinghouse, consult Placement Officer of your University, or send for our 44-page book, *Finding Your Place in Industry.*

Write: Mr. C. W. Mills, Regional Educational Co-ordinator, Westinghouse Electric Corporation, Merchandise Mart Plaza, Chicago 54, Illinois.

U-505

by Tom Mannon, M. E. '58

Late last September a huge Nazi submarine eased out of the waters of Lake Michigan, moved slowly across a beach, and amid crowds of excited people, made its way up onto Chicago's busiest drive headed straight for the Museum of Science and Industry.

Sound fantastic? It really happened! The story that lies behind this unusual event begins in mid-June of 1944, when an American destroyer, The Chatelain, cruising off the coast of West Africa, spotted an enemy submarine. Immediately, the Chatelain made preparations to overtake the vessel. A nearby aircraft carrier, The Guadacanal, was contacted, and soon several planes were in the air, ready to assist in the attack.

Acting on directions from the overhead planes that had spotted the zigzag course of the submarine, the Chatelain began blasting away at her target with depth charges. It was only a short while after the attack had begun, when the sub, a German U-505, wounded and shaken repeatedly by the powerful depth charges, appeared on the surface of the ocean. The intensity of the blast of the charges were terrific, for as soon as the sub had surfaced, its panic-stricken crew poured out of the escape hatch and into the ocean. A boarding party was quickly dispatched from the Chatelain.

The men, upon reaching the U-boat, plunged down the sub's hatch, despite the danger of hidden booby-traps and bombs and found the interior of the sub deserted, but rapidly filling with water. The small group searched quickly for the cover to fit over the opening that was admitting a heavy inpour of seawater, for they knew that within a matter of minutes the sub would be beyond saving. Finally the cover was found and replaced—just in time to prevent loss of the vessel.

The risk encountered in capturing the Nazi U-boat was well worth while, for upon close inspection of the ship's papers, a very important document was discovered. The German crew, in their hasty departure, had neglected to take with them a code that was of great value. In the words of Admiral D. V. Gallery, who directed the capture operations, "we got the Nazi naval code from the U-505—a code that enabled the United States to keep track of the Germany navy and U-boats the rest of the war."

After the necessary repairs were made on the sub, it was hooked up to the carrier Guadacanal and towed to a nearby port. Thus, the first step of the most unusual submarine journey was completed.

The capture of the German craft was to be kept in utmost secrecy, and so, after several stops in various ports, the large war prize was docked in the naval shipyard at Portsmouth, N. H.

After the war was over, and our possession of the U-505 was revealed, public interest began to rise. Especially was this the case in Chicago. Papers printed articles and letters which proposed that Chicago's Museum of Science and Industry as a fitting resting place for the submarine. Finally, because many citizens wanted to see the famous craft brought to the Windy City, a Chicago Citizens Committee was formed. This civic committee, with the help of Chicago's Mayor Kennelly, got to work on the project of bringing the U-boat to their city. It was a big project, a project that called for engineering talent that could handle 1,000 tons of German seapower.

It was decided that Seth M. Gooder, well-seasoned engineer, was the right man for the job. The committee then began the actual planning. Many ideas and possibilities were explored, and after fourteen months of surveying and blue printing, a final plan was drawn up. The committee had decided that despite the unpredictable weather, the ship had to be brought to the Museum by way of a direct approach to the shoreline. The sub was then to be rolled across the outer drive, and by means of a winch, pulled up to the front of the Museum.

While in drydock the U-505 was fitted with a cradle and set of steel rollers. (Courtesy of Museum of Science and Industry)

tonight

This man could almost reach the moon tonight...for he stands at the brink of a new age in the conquest of space, and he knows this:

If we had to, we could get him there. Given time and urgent need, we could design, build and deliver the total solution to that problem.

An entirely new development in the aircraft industry now makes this possible. It is a science and a method of developing aircraft, guided missiles and electronic systems not as traditional flying vehicles but as fully coordinated solutions to operations problems.

Today, The Glenn L. Martin Company's creative engineering resources and production facilities are among the finest in the new world of weapons systems development.

And one of the reasons for Martin's dynamic future in this new world is basic to leadership in any organization:

There is always an opening for outstanding ability.

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PRODUCTS DESIGNED FOR STEEL COST LESS BECAUSE:

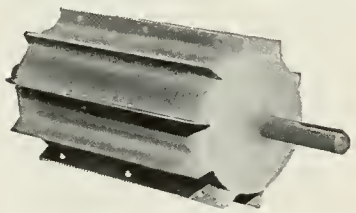
1. Steel is 3 times stronger than gray iron.
2. Steel is 2½ times as rigid.
3. Steel costs a third as much per pound as cast iron.

CUTS COSTS WITH WELDED STEEL

PRODUCTION costs largely determine whether a design is acceptable for manufacture. The successful designer therefore, seeks out every opportunity to eliminate unnecessary expense from his engineering recommendations.

Because steel is stronger, more rigid than iron, yet costs a third as much per pound, costs on many products such as the two shown below can be cut as much as 50%.

COSTS 30% LESS — Machine bracket is welded from 10 gauge metal. Weighs half of original cast design. Cut is stronger, more rigid. Costs 30% less to produce.



COSTS 45% LESS — Feeder roll is built from standard channel welded to steel discs. Steel design eliminates breakage, weighs half of former casting. Saves 45% on cost of manufacture.

Ideas for designing in welded steel

Bulletins and handbooks on latest design procedures are available to engineering students. Write:

THE LINCOLN ELECTRIC COMPANY
Cleveland 17, Ohio
THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

The famous U-505's first entrance into the Chicago river. Navy Pier can be seen in the background. (Official photograph U. S. Navy)

On May 14, 1954, the huge war memorial began her journey from New Hampshire. The Moran Company volunteered to tow the ship from Portsmouth, through the St. Lawrence, to Port Coulborne.

The Coast Guard took over from there. They towed the sub down to Milwaukee, where it was put on exhibition for a week. Incidentally, it might be well to add here that part of the money used to finance the project was contributed by the citizens of Milwaukee, (the rest was supplied by donations from Chicagoans). The U-boat was then towed to a Chicago port by the Great Lakes Dredge and Dock Company. While in port, it was fitted with a cradle and set of steel rollers by the American Shipbuilding Company.

Once the cradle was completed, the submarine was set in a 130 by 66 foot floating drydock and towed up to a special sand-filled pier, that had been constructed by the Lakes States Engineering Company. Meanwhile, the Fitz-Simons Connell Company had been hard at work dredging out a 325 foot channel in Lake Michigan that was to make it possible for the drydock to come in close to the pier.

After the Nazi sub had navigated the dredged out channel it was ready to be transferred from the drydock to the pier. This was a major step. The sub, with each end overhanging the drydock by 65 feet, was brought up to the pier, stern first. Ordinarily, according to the laws of physics, one end of the drydock would tip as the sub was rolled off. This would mean disaster. The tipping could be avoided, however, if the shifting weight were compensated for. In order to do this, mechanical jacks, equipped with weight gauges, were placed under the drydock. Then, as the sub moved onto the pier, the drydock was ballasted with water, according to the gauges.

The result was that the entire operation was completed without a single mishap. Seth M. Gooder and K. C. Thornton, the men who directed this operation, both agreed that it was the most challenging aspect of the entire moving job.

The next step, a tedious one, was to move the sub over the beach and at the same time raise the rails on which the sub rolled, to a height equal to that of the drive. This was accomplished by means of a truck-mounted winch which supplied the pulling power, and heavy duty jacks, which were used to raise the level of rails. This step, though it presented no unusual problems to the moving crew, took several days, as the operation had to be done in stages.

Then, while the sub was being readied to cross the drive, the Chicago Park District closed the Outer Drive to all traffic from 7 p. m. that evening to 7 a. m., the following morning. Finally, late in the evening, with her course clearly illuminated by light trucks from the fire department, the 252 foot vessel inched her way towards the Museum at an average of 57 feet per hour. Much later, when the ship had reached her destination, (the east side of the Museum), it was pivoted into its final resting position. The German U-505 was dedicated on September 25, 1954.

Today the Nazi submarine stands, cradled in cement, never to be used again by the evil forces that designed it. It stands as a permanent memorial to the United States Navy, and serves as a giant symbol to the prowess of our seapower, and the engineering ability of our citizens.

EXCESS HYDROCHLORIC ACID is put to work in this catalyst plant of the Morton Salt Company at Weeks Island, Louisiana. The acid is used in a process developed by a Standard Oil scientist to produce a top-quality catalyst.

What the scientist saw in the sandpile!

This story starts with a child's sandpile and a scientist's curiosity. It ends eight years later with a new top-quality catalyst—the result of a scientist's ingenuity.

One day a Standard Oil chemist took home some granular blast furnace slag from a neighboring steel mill for his children's sandpile. Suspecting that it had properties of potential value, he took a pailful back to his quarters in the Whiting Laboratory the next day.

Treating the slag with hydrochloric acid and then drying it in an oven produced 30 cc's of powder that proved to be an effective and active catalyst. However, commercial production of the catalyst was uneconomic because of the market price of hydrochloric acid. To overcome this obstacle, Standard Oil contacted the Bay Chemical Company, a salt cake producer which, at times, had difficulty marketing hydrochloric acid—a co-product of salt cake.

The Bay Company, of Weeks Island, Louisiana, now merged with Morton Salt Company, became interested in the new catalyst and built a plant with the aid of Standard Oil scientists. The output of this plant is a top-quality catalyst with unlimited new sources of raw materials.

This is only one example of what Standard Oil scientists accomplish in an atmosphere of independent research. In our constantly expanding laboratories, our scientists are free to investigate and pursue ideas, for Standard Oil knows that one of a scientist's greatest assets is his curiosity.

Standard Oil Company

910 South Michigan Avenue, Chicago 80, Illinois

STANDARD

DIG THAT HOLE

by Donna Rudig, E. Phys. '57

Drilling an oil well and the corresponding erection of the rig is not a simple process. The site of the well and the type of rigging to be used depends upon the geological characteristics of the land as well as adequate drainage and water supply, accessibility of cheap transportation, and nearness to railroads. It is the work of the geologist and the oil engineer to determine this site.

General Location

Petroleum is believed to have been formed by decayed organic matter which was subjected for a great deal of time to the action of pressure, heat and gases. Gradually the oil and gas have migrated upward into the oil sands (porous formations) and have collected into oil pools where the ground structure was right. The main geological periods in which commercial deposits predominate are the Tertiary, Permo-Carboniferous, Cretaceous, and Paleozoic. In dry rocks, oil is generally found close to the trough of synclines, and in wet, porous rocks, at the upper limit of the anticlines. In general an oil field must consist of a porous reservoir, an impervious cover ,and an underlying bed. Usually, if the top of an anticline is penetrated gas will be produced; the limbs or flanks of the anticline produce oil, and the trough of the syncline will produce water (this is in an anticlinal area).

Rigs

Once the site for drilling is determined the type of rig must be chosen. Of the two main types, rotary and standard, the standard is the oldest and generally is used in hard rock formations. This type is sometimes termed "percussion," since its drilling value depends upon the force with which the bit and stem hit the ground. The rotary method, as it sounds, is a process of boring or rotating, accompanied by a continuous mud flow. If both these systems are modified and adapted to each other the method is termed the "hydraulic circulating system." The "combination" system is used in cases where it is advisible to alternate the rotating and standard systems. In "core drilling," the boring is done within the annular space between the walls of a drill hole, the bit forming a cylinder of the material being drilled which is brought to the surface.

Drilling Equipment

The drilling equipment includes a derrick, boiler, engine and power plant, necessary actuating machinery, tools ,and accessories. The main functions of the derrick are to support drilling equipment; suspend, hoist, and lower other tools; and to shelter workers. The average derrick requires a ground space of from 20 to 24 feet square and its height is 84 feet, but the heights vary between 64 and 180 feet while base areas range between 20 to 30 feet square. Wooden derricks are often preferred to steel ones because they are easier to repair and cost less, have greater elasticity, are portable, and are not as "slippery" to work on. The steel derricks are superior in their strength and their ability to withstand rigorous climatic conditions.

Preliminary Work and 'Rigging Up'

Preliminary work is started as soon as the derrick has been erected. First a cellar (8 to 10 feet square and 6 to 20 feet deep) is excavated under the derrick floor. This cellar facilitates handling of casing, gives the temper screw free play or action, and affords safety exits in case of gas blowouts. Next the "sump" is excavated, the "dump box" (to convey debris from the bailer and sand pump to the sump) is installed under the derrick floor, and a blacksmith forge is placed on the right hand side of the derrick floor.

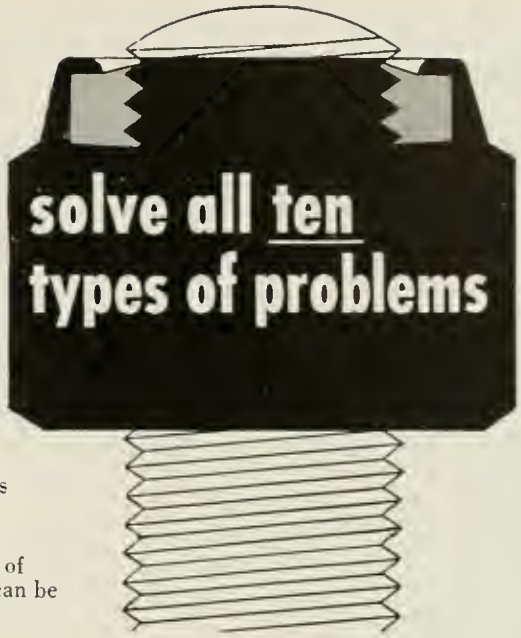
The process of "rigging up" is next begun. The boiler is placed between 50 and 100 feet from the engine house and connected. Then the engine is mounted, the belt pulley lined up with the bullwheels, the boiler and engine connection completed, and the bandwheel spiked in place. Next the engine throttle is connected to the "headache post" by means of a telegraph wheel. One end of the sand line is carried to the sand reel and spooled while the other end is fastened to the bail of the bailer. After the engine has been started and the drill cable spooled, the Barrett jack circle is fastened to the derrick floor. The water pipe and the water barrel are then placed as are the temper screw and the screw elevator. After the pulleys, sprocket chain, casing line, and sand lever are attached, the drilling equipment (drill, auger stem, sinker bar, and two jars) is located.

Drill Hole and Casing

The size of the drill hole to be dug depends upon the type of soil to be drilled and the depth of the hole. If the ground is soft a larger starting diameter will be needed than in hard rock because of the greater possibility of sliding sediment and cave-ins. This hole must be large enough to contain room in which the cleaning tools, bailers, sand pumps, and pump tubing can be manipulated.

While the hole is being drilled it is often necessary to support the walls so they will not cave in. To prevent these cave-ins steel or iron pipe known as casing are inserted into the holes. The pieces of casing are between 20 and 25 feet long and at each end the joints are threaded so that the pieces will couple together. Each piece of casing which is inserted into the drill hole has a smaller diameter than that of the preceding one. The spacing left between the two sizes of casing are filled by forcing a material such as packers in the openings. If the casing is not pulled down the hole by its own weight, it is forced down by hydraulic jacks or drive-shoes. Many times a hole is almost completely drilled while full of water, the water pressure holding in place the sides of the drill hole, and then the whole string of casing is put in at once and the water pumped out. This water is removed because it is generally hard to make a good producer of a well in which the oil sand has been drilled through with the well full of water.

elastic stop nuts solve all ten types of problems



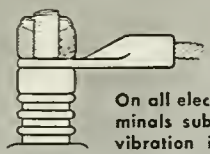
Here are ten typical fastening problems. One device, the ELASTIC STOP nut, solves them all—without additional parts or operations. Deliberately undersized in relation to bolt diameter, the red elastic collar grips the bolt with a perfect fit, exerting a continuing self-locking pressure against the threads, and holding the nut securely in place at any point on the bolt. It also provides a tight seal against the bolt threads, which prevents seepage and wear-producing axial play. And because the bolt threads are protected against moisture from without, the nuts are not "frozen" to the bolt by corrosion.

ELASTIC STOP nuts stay tight, right where you put them, in spite of vibration and stress reversals. Yet they are not jammed in place, and can be removed with a wrench and reused many times.

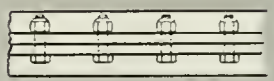
For further information on ESNA self-locking fasteners, mail the coupon below.

TIGHTENED AGAINST THE WORK

Wherever a vibration or impact proof bolted connection is desired.

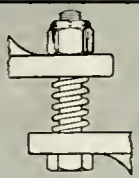


On all electrical terminals subjected to vibration in transit or operation.

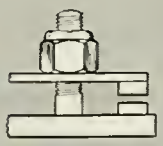


For uniform and precise prestressing of multiple bolt assemblies . . . adjusted by predetermined wrench torques.

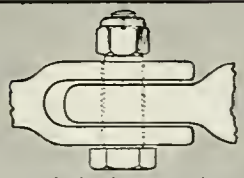
LOCATED ANYWHERE ON THE BOLT



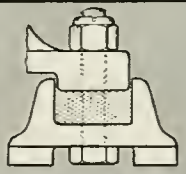
Spring-mounted connections or dynamic balancing, where nut must stay put yet be easily adjusted.



On make-and-break adjustment studs where accurate contact gaps are required.

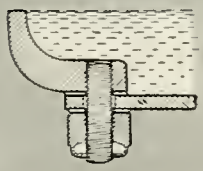


For bolted connections requiring predetermined play.



For rubber-insulated and cushion mountings where the nut must not work up or down.

FOR MANY SPECIAL APPLICATIONS



To seal bolt threads where elimination of leakage past stud threads is necessary.

To seal bolt threads where it is necessary to protect them from corroding elements.

To obtain delicate adjustments for applications such as bearing locknuts where precise adjustment is essential.

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ROLLPIN TRADEMARK

Dept. N40 , Elastic Stop Nut Corporation of America
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☐ Elastic Stop nut bulletin ☐ Here is a drawing of our product. What self-locking fastener would you suggest?
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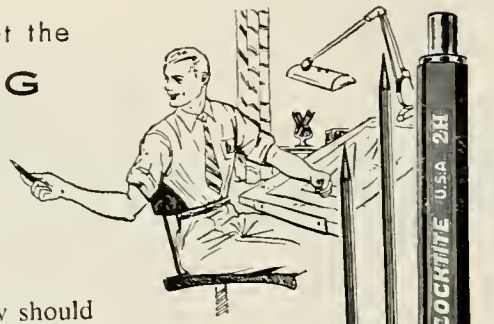

Your tools of tomorrow should be your tools of today. When you graduate and start upon your own career you will find that the top engineers, architects and designers use CASTELL—either the famous wood pencil or LOCKTITE Holder with 9030 lead.

CASTELL is smoother, stronger, lays down greater depth of graphite on the drawing. It is uniformly excellent in all 20 degrees, 8B to 10H.

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Every engineer and surveyor would gladly cut his leveling time and costs in half. K&E now offers the answer with the amazing new Ni2 *Self-Leveling* Level. It performs any kind of leveling, from rough cross sectioning to first order work. Rugged yet highly accurate, it is set up in a moment, because *it actually levels itself*. Such economy is a key to K&E's 87 years of leadership in drafting, reproduction, surveying and optical tooling equipment and materials, in slide rules and measuring tapes.

Who is the Engineer?

There is a train crew consisting of 3 men, an engineer, a fireman, and a brakeman. Their names in alphabetical order are: Jones, Robinson, and Smith.

On the same train there are 3 passengers. Their names in alphabetical order are Mr. Jones, Mr. Robinson, and Mr. Smith.

The following facts are known:

Mr. Robinson lives in Detroit.

The brakeman lives half way between Chicago and Detroit.

Mr. Jones earns exactly $10,000. a year.

Smith once beat the fireman at billiards.

The brakeman's next door neighbor, one of the 3 passengers mentioned, earns exactly 3 times as much as the brakeman.

The passenger living in Chicago has the same last name as the brakeman.

Who is the engineer?

Solution:

The brakeman's name cannot be Robinson. The brakeman's next door neighbor cannot be Jones because it is impossible to earn *exactly* one third of $10,000. Therefore Mr. Jones lives in Chicago and the brakeman's name is Jones. Smith cannot be the fireman and therefore must be the engineer.

"Why don't you like girls?"

"They're too biased."

"Biased?"

"Yes, bias this, and bias that, until I'm broke."

* * *

"Ever been to the city, Jeff?"

"Yep, once."

"How was it?"

"Saw a lot of crazy people?"

"Well, some was runnin' to work."

* * *

Waiter: (To customer eating soup): "May I help you, sir?"

Diner: "What do you mean, help me? I don't need any help."

Waiter: "Sorry, sir. From the sound I thought you might wish to be dragged ashore."

* * *

The reason for the amber light on the traffic signal has finally been revealed: It gives the Scotchmen a chance to start their engines.

* * *

An old gent was passing a busy intersection when a large St. Bernard ran by, knocked him down.

A moment later, Crosley car skidded around the corner and inflicted further damage. A bystander helped him to his feet, and someone asked if the dog had hurt him.

"Well," he answered, "the dog didn't hurt so much, but that tin can tied to his tail nearly killed me."

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This servo-motor is smaller than a household fuse—weighs only about one and one-half ounces. Yet, without such powerful compact devices, modern industry could not function efficiently.

Servo-motors are the slaves that carry out the commands of servo-mechanisms . . . the workhorse and watchdog combination of today's automatic control systems. In industry they provide the precision needed for machining propellers . . . the uniformity necessary in the processing of food, chemicals and petroleum . . . the phenomenal speed and efficiency required in electronic computing systems . . . and the control requirements of hundreds of industrial and military applications.

MIND-MADE MIRACLE . . .

How many men worked out this miracle of precise control of power and movement? Physicists and engineers supplied theories . . . technicians and designers developed them . . . chemists, metallurgists, machinists . . . these and scores of others worked their splendid best. But how did they know how? Not just from what they learned in school . . . or from their immediate associates. For, while these helped, this whole business of automatic control is growing so fast and changing so rapidly that basic terminology and concepts have not yet been settled.

So these men of science and industry look to America's all-seeing, all-hearing and reporting Inter-Communications System for news of the needs and of the new in their field.

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Complete communication is the function, the unique contribution of the American business press . . . a great group of specially edited magazines devoted to the specialized work areas of men who want to manage better, research better, sell better, buy better.

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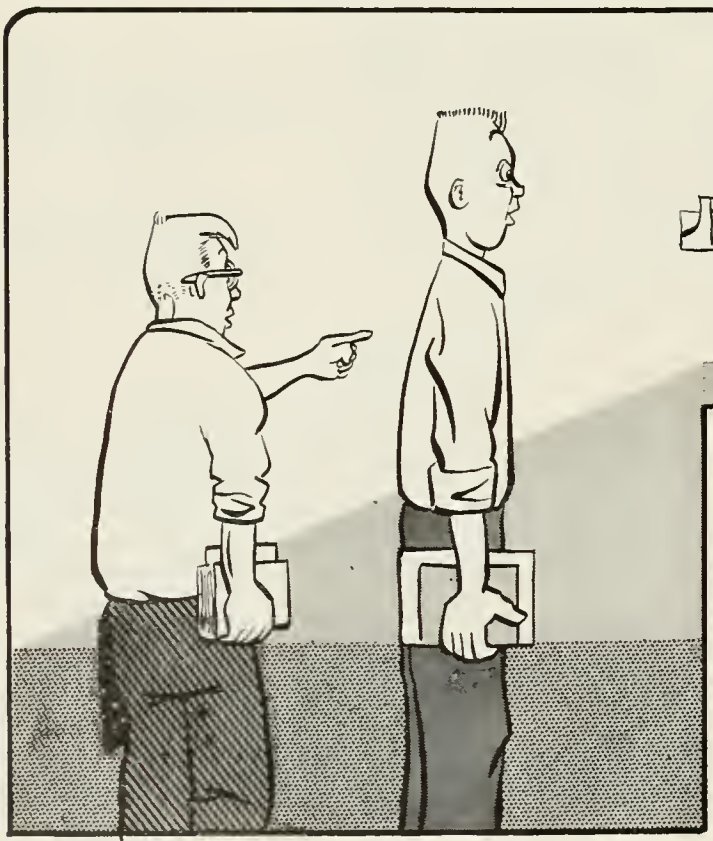
THIS IS

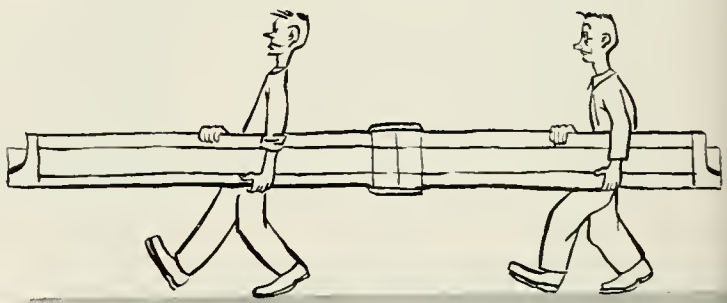
ONLY ONE PAPER TURNED IN! THE TROUBLE WITH YOU IMBECILES IS THAT YOU'RE TOO BLASTED LAZY!!

I THOUGHT YOU SAID YOU HAD ONE PAPER TO GRADE TWO WEEKS AGO! YOU'RE TOO BLASTED LAZY!

NOW DEAR, DON'T BE TOO HARD WHEN YOU GRADE THOSE EXAM PAPERS TONIGHT!



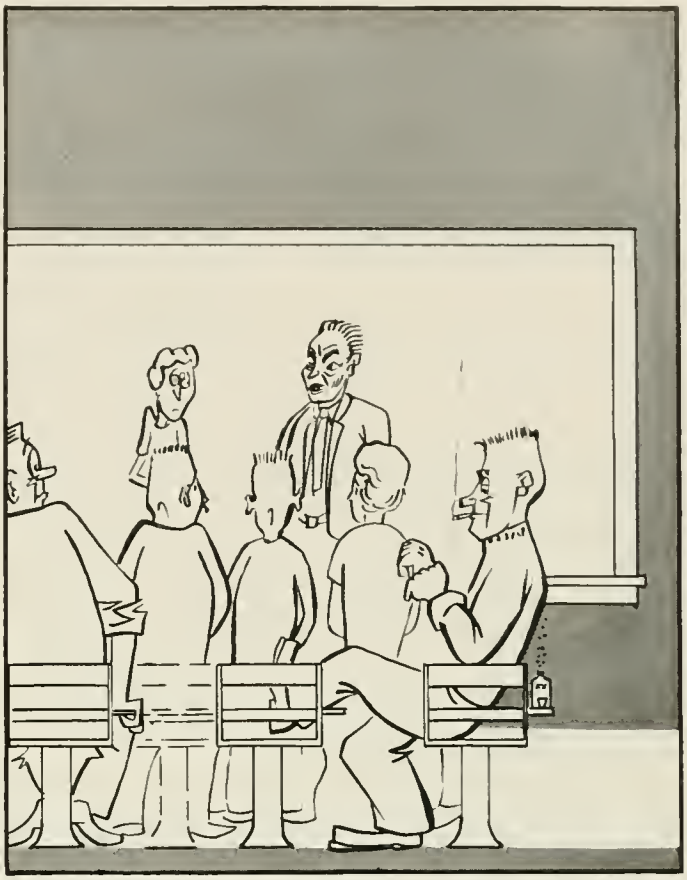
THEY'RE THE ONLY TWO GUYS ON CAMPUS WHO CONSISTENTLY TRY TO BEAT THOSE INFINITY PROBLEMS



BUT I THOUGHT YOU SAID YOU WERE IN ELECTRICAL ENGINEERING. ARE YOU SURE YOU CAN'T CHANGE FUSE

...OLLEGE!! by Dave Templeton

...ISS FALSEBOTTOM! WHAT'S THIS VICIOUS ...UMOR GOING AROUND CAMPUS ABOUT ...Y BEING A CANTANKEROUS OLD ...ISFIT!!



NOW, MISS PENDLESTAFF, WHERE IS THIS STUDENT YOU THINK YOU MIGHT HAVE TROUBLE WITH?

...RENSHAW! I TOLD YOU NOT TO PICK ...P YOUR PAPER UNTIL AFTER ...LASS!

SO I SAID TO HIM, 'LOOK, PROFESSOR GRUFF, CURVE OR NO CURVE, I THINK YOUR GRADES ARE LOUSY!'

Engineering Leadership

by T. H. Chilton

Prepared in response to invitation for article to appear in member magazines of Engineering College Magazines Associated.

Who will be the leaders of the engineering profession twenty years from now? Forty years from now?

It is my hope that these destined leaders will be among the readers of this brief article. Merely to pose such questions will be enough to fire or rekindle their ambitions; to fortify their determination to excel, each in his chosen line, and to merit recognition from their fellows.

It is not just these, however, that I am addressing. It is the whole body of prospective members of the profession. It is their choice of leadership that will determine the direction in which the profession will move.

We celebrated in 1952 the Centennial of Engineering, signaling the 100th anniversary of the founding of the American Society of Civil Engineers. What strides America has made in that time? The spread of the railways across the continent, helped by the introduction of the Bessemer process for making steel and then the open-hearth; the electric industry, the electric light, the dynamo, and the electric motor; the automobile, the highway system, the petroleum industry; the airplane, making us neighbors to the whole wide world; mass production, making labor-saving devices available to the mass market; new metals, aluminum, magnesium, titanium; the chemical industry, bringing us luxuries, comforts, and aids to health and prolongation of life; the telephone, and now electronics, affording instant communication, and bringing information and entertainment into every home at any hour of day or night; the advent of atomic power, promising freedom from dependence on fossil fuels, and perhaps by the very awesomeness of its force making large-scale wars less probable. Every branch of science and technology, of course, has had its part in the achievements of these 100 years, but it is the engineer who has been at the focal point of every one of them. It is the engineer who has been there to make them work: that has been his business.

With technology advancing at that pace, what will be the achievements of the next hundred years? It staggers the imagination. If not to project so far, what about the next forty years, the period which your career will have a part in shaping? Or within some almost perceptible horizon, the next twenty years? If we only project at the present pace, without taking account of its acceleration, any of you can foresee the demands on technological skills that will crowd in on you in your own engineering careers.

Now I would like to ask you to think what kind of engineers these were that helped bring about the achievements of the past century. With such accomplishments to their credit, you can be pretty sure that they were, most of them, men who took every problem for a challenge, every difficulty for an opportunity. I can't believe that they were clock-watchers—or, "in case they didn't like inside work, whistle-listeners." By and large, they must have been men who set out, not just to earn a living, but to help make the world a better place to live in. It was thus that they helped to establish and constitute engineering as a profession as we know it.

Now, what direction will the profession take during your active practice of it? It will depend on the leadership you exert, or the leadership that you elect to follow. The choice, in any event, is yours.

The kind of leadership you may exert later will be determined in large measure by the proven leadership you choose to follow now. Where can you find such leadership? The profession is not static: the leaders in the rapid pace of today's engineering developments are active here and now. Recognizing their obligation to advance the profession as well as to make their individual technological contributions, they have associated themselves with the societies representing their branch of engineering, and can be found guiding its counsels, working for its advancement, and many of them working toward the goal of a common organization that will represent the profession as a whole. Read the biographical accounts of recent candidates for high office in the society representing the branch for which you are preparing yourself, as given in the society's magazine every year. You'll find plenty of examples among such men that you will want to emulate.

Nearer at hand, you will find outstanding engineers in every branch taking part in activities of the local sections of the engineering societies, and you can by direct observation decide for yourself their fitness for leadership.

It is at this point that I want to draw attention to what I consider a danger that confronts the profession at the present time. I do not know whether it arises out of a herd instinct for security; or out of the practice of some unenlightened managements in dealing with members of their engineering staff *en masse* instead of treating them as individual members of a creative profession; or out of vague feelings that engineers generally have not participated in the increases in earnings that manual workers have been gaining (actually made possible by technological advances to which engineers have largely contributed). For whatever cause, some have come to advocate that engineering employees should join together in bargaining groups, or unions. Such unions would, they insist, of course be limited to professional personnel, as specifically provided under the protective safeguards of the present U. S. statutes. It may be true that one can find, here and there, employers of engineers who confound the creative contribution made by professional engineers on their staffs with the work of subprofessional grades, and fail to accord engineers appropriate recognition as members of a profession. It has also been one of the marks of our times that the income of intellectual workers generally has not increased as rapidly as that of skilled or semiskilled manual wage-earners in the inflationary era of the past twenty years or so, which is all that most of us have experienced. But there are other avenues available for improvement. Without dependence on "collective bargaining," the less enlightened employers can be brought to understand what it is that members of the engineering and scientific professions feel they need in the way of recognition, in such simple matters as privilege of attending society meetings, for example. And surveys conducted by the professional societies will show both employers and those earning salaries how rates compare with other callings.

This is a serious matter. Several of the engineering societies have felt strongly enough about it to adopt a resolution, offered through the Engineers Joint Council, as presented by the American Institute of Chemical Engineers, declaring that "the enhancement of the status of the engineer is best promoted by his reliance upon his personal professional growth and accomplishment, and that his status as a professional man is endangered by reliance upon group efforts to act on his behalf in reaching short-range economic objectives; while at the same time the corresponding obligation is laid upon the employer of engineers to give each professional employee his due individual recognition as a member of the profession."

The important fact I want to point

WHO ARE INDUSTRY'S TOP YOUNG SCIENTISTS ?

Ten men between the ages of 26 and 40 were featured in a recent national magazine article which presented a portrait of the young scientist in America today. These particular men are a sample of the most brilliant young scientific minds in industry.

It's interesting to note that three of the ten are with Bell Telephone Laboratories, three with General Electric and one each with four other companies.

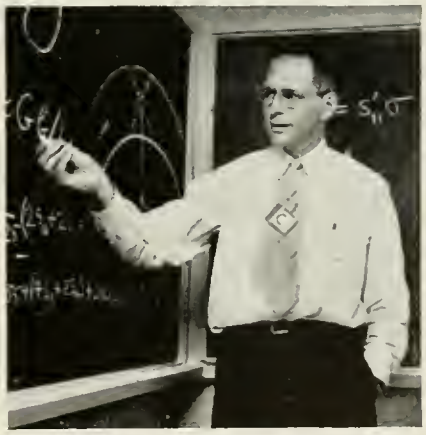
The variety of opportunity in research and other phases of telephone work has always attracted an unusually high percentage of the nation's best young men.

Consult your Placement Officer about opportunities with Bell Laboratories . . . also with the Bell Telephone Companies, Western Electric and Sandia Corporation. Your Placement Officer will be glad to give you details.

THREE OF THE TEN ARE AT BELL TELEPHONE LABORATORIES—

Mathematician Claude Shannon won fame for his Communication Theory

Physical Chemist William Baker introduced new concepts that have improved synthetic rubber and fibers



Physicist Conyers Herring is known for his understanding of the quantum mechanics of the solid state

BELL TELEPHONE SYSTEM

out, however, is that engineers qualified to exert leadership in the profession almost inevitably are called, at some stage in their careers, from the ranks to some level of supervisions of engineers or management of an enterprise. Thus, under the provisions of the laws that protect labor unions from domination by management, they become disqualified from membership in groups made up of employees to act as bargaining agencies. Adherence of engineers to such groups therefore deprives them of the opportunity to associate with the more rapidly advancing members of their profession, on which I have placed such stress.

It is no more true than with most epigrams that "to be a leader of men, one must turn his back on men." The leader with the most devoted following is the one who has the real individual interest of his men at heart. The engineer who advances upward into the levels of management of engineering forces does not easily forget the steps by which he rose. In an organization in which all levels are joined in support of the profession, he can maintain such association as will assure his appreciation of the aspirations and needs of the rank and file.

Finally, I cannot believe that the engineer entering the profession today wants to limit in any way his advancement, in the face of the opportunities awaiting him in this challenging world of complex technology. I believe he wants to be free to choose what leadership he will follow in setting out to make his own mark in the profession. I believe he only wants to be assured that he can earn recognition based on his own contribution in his technical field, whether as an individual or as a member of a team.

What kind of leadership are you willing to follow? What kind of leadership are you prepared to offer when your chance comes?

A faith healer ran into his old friend Max and asked how things were going.

"Not so good," was the pained reply. "My brother is very sick."

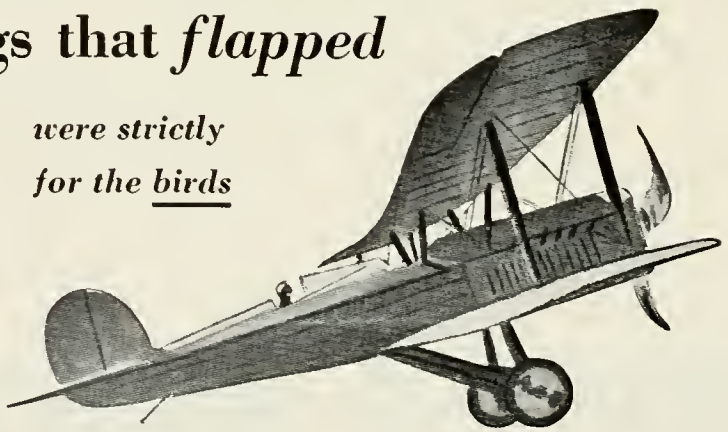
"Your brother isn't sick," contradicted the faith healer, "he only thinks he's sick. Remember that: he only *thinks* he's sick."

Two months later they met again and the faith healer asked Max, "How's your brother now?"

"Worse," groaned Max, "he *thinks* he's dead."

Wings that *flapped*

were strictly for the birds



KP-BS Bearing

A generation ago, about everyone thought that airplane wings should be rigid to be safe. Not so today. Designers of today's high speed planes have found that safety hinged on wing deflection.

To insure unrestricted control systems on wings that bend, Fafnir developed a standard series of Self-Aligning Torque Tube Type Ball Bearings which provide friction-free movement, reduce cost and weight. By keeping in step with aircraft progress, Fafnir continues to lead in the production of aircraft bearings. The Fafnir Bearing Company, New Britain, Conn.

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BALL BEARINGS
MOST COMPLETE LINE IN AMERICA

Jack and Jill went up the hill.
Upon a moonlight ride.
When Jack came back, one eye was black.
His pal, you see, had lied.

* * *

Women's best asset is man's imagination.

* * *

Lipstick is merely something to give new color to an old pastime.

* * *

Dedicated to the Junior class at Union Hospital.

Student Nurse: "Every time I bend over to listen to his heart his pulse rate goes up alarmingly. What should I do?"

Instructor: "Button your collar."

* * *

Liquor Salesman: "Y'know, I hate to see a woman drink alone."

Food Salesman: "I hate to see a women eat alone."

Mattress Salesman: "Say, what do you fellows think of the cold weather we've been having?"

* * *

Customer: "Have you a book called 'Man, the Master of Woman'?"

Salesgirl: "The fiction counter is to your left, sir."

* * *

Three old men were discussing ways of dying. The first, 75, decided he'd like to drive over a 5,000-foot cliff. The second, 85, said he'd take his in a 600-mph jet. "I've got a much better idea," said the third, aged 95. "I'd like to be shot by a jealous husband."

* * *

Through the smoke and ozone fumes
the student slowly rises;
His hair is singed, his face is black, his
partner he despises;
He shakes his head and says to him, with
words so softly spoken,
"the last thing that you said to me was,
'Sure, the switch is open.' "

* * *

Prof. Pietenpol: If, in going down this incline, I gain four feet per second, what will be my condition after 25 seconds?

Smart sophomore: You'll be a centipede.

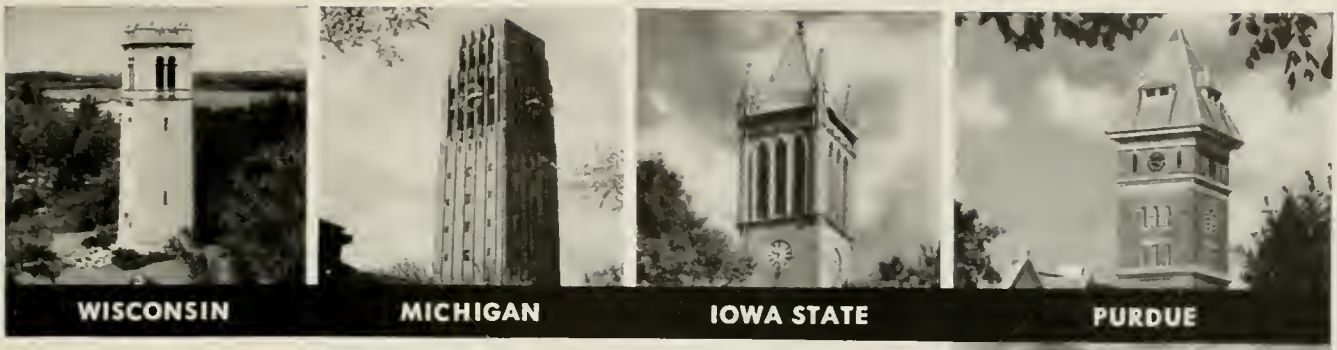
* * *

Little girl to her mother: "Will I walk to heaven on a golden bridge—The minister said so."

"He's wrong, dear, there are no bridges in Heaven—it takes engineers to build bridges."

* * *

"Twin beds are well and good," said the blushing young bride to the salesman in the furniture store, "but there is no use buying them until we get twins."

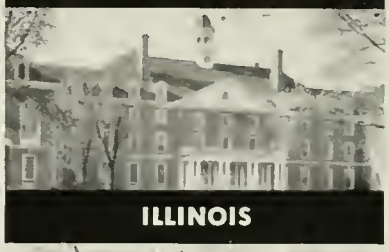


these are Mighty Good Hunting Grounds!

Year in and year out, we limit our search for electrical, mechanical, industrial and general engineers to these nine schools. Experience has taught us that it's unnecessary to look beyond these nine in our search for our design, production and sales engineering talent.

Experience also has shown that those who join us find Square D a mighty good company to be with. Most of these men are still with us, growing and prospering with the constantly expanding electrical industry.

Why not let us tell you more about Square D and what we have to offer?



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We'd like to send you a brochure, "Your Engineering Career." It gives the simple rules to follow in selecting an engineering career.

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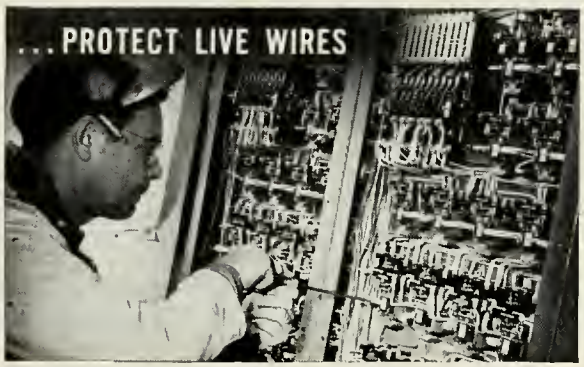
Most businesses are helped today by Hercules' business . . . the production of synthetic resins, cellulose products, chemical cotton, terpene chemicals, rosin and rosin derivatives, chlorinated products, and many other chemical processing materials—as well as explosives. Through close cooperative research with its customers, Hercules has helped improve the processing or performance of many industrial and consumer products.



SHORT CIRCUITS STYMIED—
Complicated electrical installations give longer, more dependable service when vinyl wire insulation is made with Hercules Hercoflex® 150. Hercoflex 150 is one of the Hercules family of vinyl plasticizers that are used in products ranging from toys to garden hose.

EASY TO HANDLE —
These kitchen utensils not only make a woman's job easier, but their brightly colored handles add a decorative touch as well. The handles are molded with Hercules Hercocel® cellulose acetate. In sales, design, and production, Hercules' services to the plastics industry keep products on the move.

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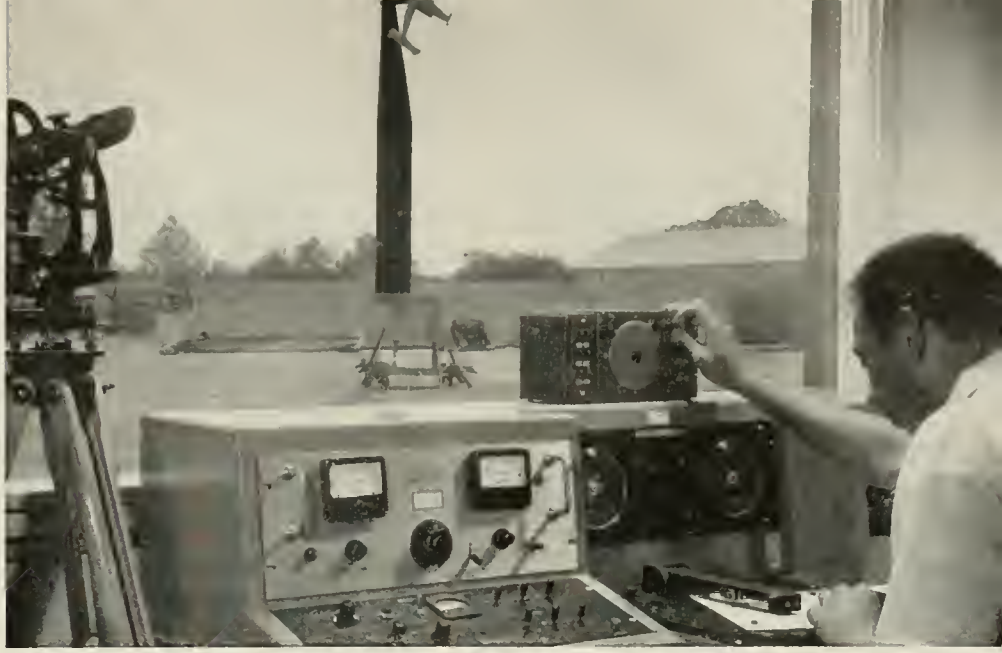

Electronics Research Engineer Irving Aine records radiation antenna patterns. Twenty-two feet plastic tower in background eliminates ground reflections, approximates free space. Tower is of Lockheed design, as are pattern integrator, high gain amplifier, square root amplifier, logarithmic amplifier.

Antenna development program at Lockheed expands

Electronics Research Engineer F. R. Zboril measures input impedance of a scale model helical antenna array used for ground tracking of missiles. Most of Lockheed's other antenna work involves advanced research studies on flush mounted antennas.

Lockheed's diversified development program presents Electronics Engineers qualified for airborne antenna design with a wide range of assignments in communication, navigation and microwaves. Antenna design is one of the fastest growing research and development areas at Lockheed.

Studies embrace virtually all types of aircraft, including the Super Constellation radar search plane—a type of aircraft developed and produced exclusively by Lockheed.

Career Positions at Lockheed

Lockheed's expanding development program has created a number of positions for Electronics Engineers and Physicists to perform advanced work in antenna design.

In addition Lockheed has a number of positions open for engineers in aerodynamics, thermodynamics, flight test analysis, structures and design to perform advanced studies on such diverse projects as: Applications of nuclear energy to aircraft, turbo-prop and jet transports, bombers, trainers, supersonic aircraft with speeds surpassing Mach 2, and a wide range of classified activities.

Program for Advanced Study—To encourage members of its engineering staff in study leading to advanced degrees, Lockheed reimburses 50% of the tuition fee upon successful completion of each course relating to the engineer's field at the University of Southern California and University of California at Los Angeles. Both universities offer a wide night school curriculum in science and engineering.

E. O. Richter, Electronics Research department manager (seated), W. R. Martin, antenna laboratory group engineer (standing), and J. L. Rodgers, electronics research engineer, discuss design of corrugated surface antenna.

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AIRCRAFT CORPORATION

BURBANK **CALIFORNIA**

Chicago's . . .

FILTRATION PLANT

by Al Shiner, M. E. '56

The way was cleared for construction of the new Chicago North Side filtration plant (Illinois Tech. Jan. '54) as the U. S. Supreme Court refused to review a protest.

The high court reported Oct. 19 that it would not hear the appeal by a group of property owners fighting the placing of the plant in Lake Michigan north of Navy Pier.

The protest questioned whether the secretary of the Army had power to authorize the 70-acre fill in Chicago's downtown harbor when the project was not to improve navigation but for the benefit of the city.

The property owners won an injunction in Cook County Circuit Court in August, 1953, which halted work on the $85 million plant after $3 million had been spent.

Derrick No. 58, a 30 ton, eighty foot boom, one of the many working on the construction of Chicago's Filtration Project at dock next to Navy Pier.

During the digging operations, a barge is tied along side the derrick. Pictured is a load of clay after being removed from the lake. The barge is then towed 13 miles out and dumped.

The work was resumed after the Illinois Supreme Court in May ordered the injunction dissolved. The appeal to the U. S. Supreme Court was taken from the state court's decision.

George DeMent, commissioner of public works, said the Great Lakes Dredge & Dock Co. expects to complete a coffer dam next summer.

By then, DeMent said, the city will be ready to let contracts for the rest of the work.

The coffer dam consists of an earth fill supported by sheet steel piling. When it is tight, water will be pumped out and construction started inside the enclosure.

Mayor Kennelly termed the court's decision "a great step toward providing filtered water for all Chicagoans."

The plant will filter water for the two-thirds of the city's population north of Pershing Rd. South of there, filtered water is already provided by the South Side filtration plant.

The north side now gets chlorinated raw water from Lake Michigan.

Property owners in the vicinity fought the site in the harbor as an improper one. Other sites, both on land and in the lake had been proposed. Navigation interests also objected to the taking of harbor space but did not join in suit.

Edward R. Johnson, attorney for the petitioners, was out of the city. Members of his law firm said he and his group would decide whether any further action is to be taken.

$ $ $

2 - $50 Awards

Two cash awards of $50 each will be awarded to the author of the best TECHNOGRAPH staff article and the best non-staff aricle submitted to the ILLINOIS TECHNOGRAPH.

Rules:

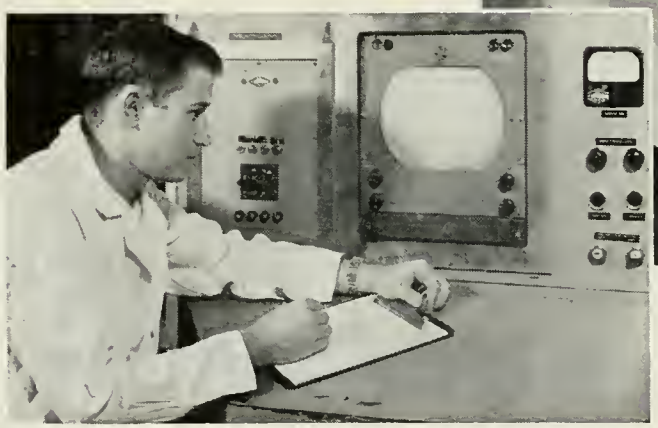
1. Articles must be submitted by the author not later than March 1, 1955.
2. It must not have been previously published.
3. It must pertain to engineering in some way.
4. All articles must be doublespaced typewritten.
5. Technograph staff members are eligible for only one of the prizes.
6. Some articles will be printed in the TECHNOGRAPH.
7. None will be returned, but they will be kept on file and may be printed later.
8. Please include pictures and permission for us to use them.
9. Any number of articles may be submitted by the same author.
10. The Technograph editorial staff will be judges for the non-staff articles.

Notes:

1. Ten typewritten poges with pictures makes three pages in the magazine.
2. Use rhetaric department punctuotion and capitalization.
3. Any national company will be glad to send you photographs and information.
4. Get started naw and get several articles written ond submitted by March 1, 1955.

$ $ $

ALLISON Engineers Pioneer VTO Power Plant Development



GEORGE D. KEMP, who received his B.S. in Mechanical Engineering from Colorado A. and M. last June, is shown recording data on the engineering log sheet from the industrial TV screen in the VTO test cell. George—now in the Test Operations group in the Experimental Test Section of Allison—is working on the T40 turbo-prop engine which powers the Convair XFY-1 and the Lockheed XFV-1 vertical take-off aircraft.

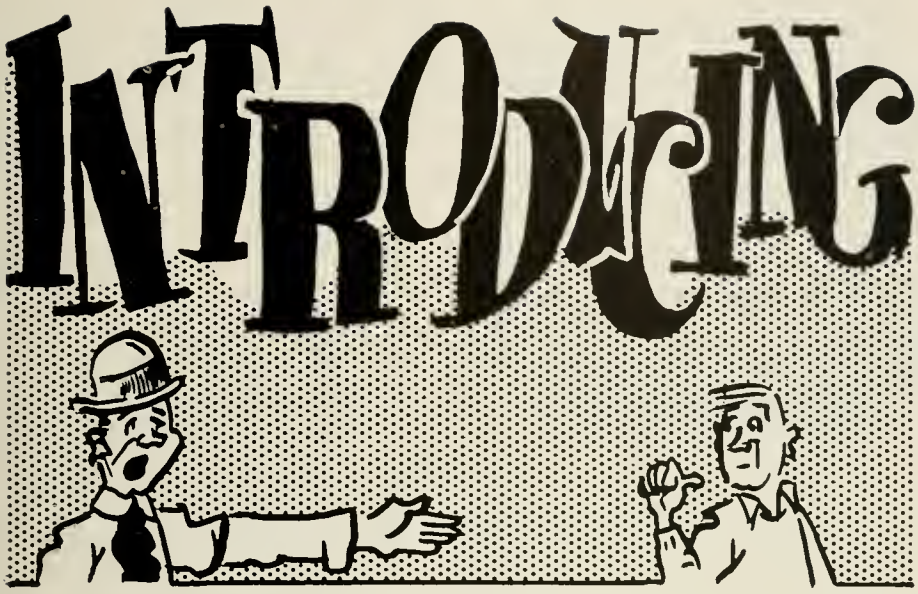
● Early in '51, Allison undertook the power plant development for vertical take-off airplanes following the Navy's request for a high-power, low-weight turbine engine which could be adapted to vertical operation.

With modifications, the Allison T40 turbo-prop engine—with its extremely high power-to-weight-ratio—was selected to do the job. The vertical operation necessitated basic design changes, such as changing the oil system so it would function in both vertical and horizontal positions. Too, it was necessary to modify the reduction gear, giving a higher propeller RPM and increased thrust. And, with the specially designed propellers required by the VTOs, the control system was redesigned.

Then, to test the engine, a radically new test stand was designed and built. Allison engineers converted a test stand previously used for low horsepower reciprocating engines to one (shown above) capable of accommodating VTO engines in the various positions from horizontal to vertical. With the huge 72,000 pound tunnel completely enclosing the engine and propeller, a television was installed in the control room so engine operation could be observed in any tunnel position.

The VTO power plant project is typical of the variety of challenging problems handled by the Allison Engineering staff. And, because it is continually pioneering in advanced engineering developments, Allison needs additional technically trained men, especially young graduate engineers. Why not plan now for your engineering career at Allison. Write for information:

R. G. GREENWOOD, Engineering College Contact,
ALLISON DIVISION, General Motors Corporation, Indianapolis 6, Indiana.



by Millard Darnall, Ag. E. '56, and Don Kesler, E. E. '56

DON KESLER

Don was born on a farm near Claremont, Illinois and now lives in Urbana, where he has lived for the past six years. Previous to living in Urbana, he obtained a bit of the South while living in Nashville, Tennessee.

Last year Don was assistant editor on the Technograph and also make-up editor for awhile. He is always around the office as his position as editor requires an awful lot of time. He is the one who is continuously striving for a better magazine. More power to him in that respect.

DON KESLER

He is a junior in E.E. and his pet hobby is sports cars. Last summer he built a sport car from a revamped Crosley frame and stock engine. To this he added an aluminum body. It is a very sleek automobile with its low cut lines. Although it is not yet completed, it appears to be a very nice little sports car. You can recognize Don by his little yellow sports car which will probably be seen all over the campus the rest of the time he is here in school.

Don is the type of person who will be a very good boss in running of the magazine this year.

"Darling, you look beautiful in that dress."

"Oh, it's just something I threw on."

"Yes, thought so, darned near missed, didn't cha?"

* * *

You ought to laugh at these jokes, your grandfather did.

* * *

"The Irish aren't so tough."

"How come?"

"Me and my brother and the two guys across the alley almost licked one last night."

* * *

I've decided to get a divorce. My wife hasn't spoken to me in six months.

Better think again. Wives like that are hard to find.

* * *

Blue eyes gaze at mine—vexation.
Soft hands clasped in mine—palpitation.
Fair hair brushing mine—expectation.
Red lips close to mine—temptation.
Footsteps—damnation.

* * *

Don't worry if your grades are low,
And your rewards are few;
Remember that the mighty oak
Was once a nut like you.

DR. E. A. REID

Dr. E. A. Reid is one of the old timers on campus that you should know. He has been teaching for 37 years. He teaches machinery laboratory to E.E. students as well as being in charge of machinery laboratory courses. Dr. Reid makes all the teaching assignments in his department. He is in charge of equipment inventory. He sees that all the equipment valued over ten dollars gets a State of Illinois number and checks frequently to see that it is in its proper place and not lost.

DR. E. A. REID

Dr. Reid graduated from the University of Illinois. At that time, an electrical engineering degree was assumed to be in machines. There was little else then.

He taught at the University of Minnesota before coming to the U. of I. For many years Dr. Reid spent his summers working for industry. He worked for a lot of different companies. The experience he gained was as valuable to his students as to himself. A summer home in Minnesota is his vacation spot now. For several years he has quit working for industry in the summer and has been vacationing 200 miles north of Minneapolis.

Aside from his teaching, Dr. Reid is the counselor for the student branch of the American Institute of Electrical Engineers. The A.I.E.E. is a very prominate student organization.

Only a man who enjoys teaching so well could survive 37 years of teaching college students.

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A few figures tell the story.

. . . 7 years of painstaking analysis, research and design by engineers from nearly every field of technology.

14,200 hours of experimental engine operation in test cells and in flight test.

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As a result, America now has the world's most powerful production aircraft engine — the J-57 turbojet. Careful engineering development like this has made Pratt & Whitney Aircraft the world's foremost designer and builder of aircraft engines.

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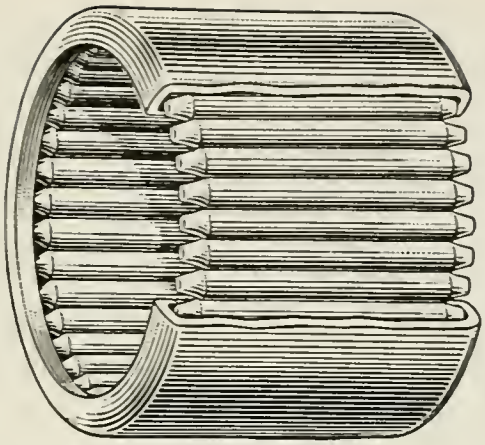

This is a Torrington Needle Bearing

Designed for Today's Needs and Tomorrow's Trends—
Needle Bearings Offer A Unique Combination of Advantages

The Torrington Needle Bearing has two component parts—the full complement of relatively small diameter, thru-hardened, precision-ground rollers and a case hardened retaining shell by which they are held.

The bearing is a complete unit in itself, and is easily pressed into position in a bore machined to proper dimensions. The advantages of this unit construction in simplifying installation and speeding assembly are readily apparent.

High Radial Capacity

Of special importance is the high capacity of the Torrington Needle Bearing. This efficient anti-friction unit can carry a greater radial load than any other bearing of comparable outside diameter due to the large number of rollers. The small cross section of the bearing allows a large shaft which permits a rigid design with minimum shaft deflection.

Efficient Lubrication

The method of lubrication is another feature of the Torrington Needle Bearing. The retaining shell with its turned-in lips provides a natural reservoir for the lubricant. Thus the needle rollers turn in an oil or grease bath and continually bring up a fresh film of lubricant—insuring rotation of all moving members on a fluid film.

Low Cost

The size of the Torrington Needle Bearing, coupled with the simplicity of its construction, makes it a comparatively inexpensive anti-friction unit. Its compact size encourages simplified design which requires less material in surrounding components. This also contributes to further cost reductions.

The shaft serves as the inner race in the majority of Needle Bearing applications and therefore should be hardened and ground to proper dimensions. However, where it is desirable to use an unhardened shaft, an inner race can be supplied.

For Modern Design

Where the efficiency of anti-friction operation is desired, and where space, weight and cost are vitally important considerations, Needle Bearings provide a logical answer. That's why you will find them used in an ever-growing list of applications.

This is one of a series of advertisements designed to give you the latest engineering information on Needle Bearings. Should you have occasion to work with bearing design or wish more information, write our engineering department.

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WPGU

by O. Pat Colvin, Econ. Graduate

Radio station WPGU will observe its first anniversary this month and during its first years of operations the station has made great strides toward high-caliber service for its listeners on the University of Illinois campus.

The idea for the radio station was spawned early in October, 1953, by a dozen electrical engineering students living in and around the Parade Ground Units. Originally the group planned to use a simple phonograph oscillator as their broadcasting instrument, but standard broadcasting equipment was acquired on loan from the University station WILL through Professor Frank Schooley, WILL station manager and a member of the School of Journalism and Communications faculty.

After two months of preparation, the first program was broadcast from WPGU at 7 p. m. on Dec. 6, 1953. Facilities for the studio—first located at 1340 Arbor but later moved to its present location at 1241 Euclid in the Parade Ground Units—were donated by the University housing division.

Technically, WPGU is known as a carrier current station since the output of the transmitter is fed onto local power lines and the signal is carried through this medium. This process, which is sometimes referred to as a "wired-wireless," needs a power of 15 watts to operate.

Federal Communications Commission regulations do not allow WPGU and other similar stations to use antennae to send out the electromagnetic radio waves. FCC regulations also limit the field strength to 15 microvolts per meter at approximately 300 feet from anything connected to the transmitter such as the previously mentioned power lines.

Through the medium of the power lines, WPGU's signal is carried throughout the entire Parade Ground Units' area, the Stadium Terrace housing units, all of the Men's Residence Halls, and surrounding fraternities, sororities, and independent housing. The station's coverage was increased last March when a remote control transmitter was placed in Lincoln Avenue Residence Hall, home of over 500 coeds. The transmitter in LAR is operated via leased telephone company lines.

By using this method of remote control transmitters, Art Anderson, electrical engineering junior who is chief engineer for the station, hopes to increase WPGU's coverage of the campus area during the next few months. At present the station has an estimated coverage of over 4,000 people living on the University campus.

The station's staff is made up entirely of University students. No professional assistance is used and all of the staff members donate their time as a campus activity.

From the nucleus of the original 12 electrical engineering students who first began operations of WPGU, the staff has grown to its present size of over 60 members. There are 40 announcers and 20 engineers working for the station. The announcers do all of the broadcasting while the engineers are in charge of the operation and maintenance of equipment. There are three staff members on duty every day from 7 p. m. to 12:15 a. m.—the hours the station is on the air.

The station operates as part of the Parade Ground Residence Association and any money needed for regular operation of the station is provided by this group. The PGRA council appoints the station manager who in turn picks his own administrative staff.

WPGU operated on a frequency of 640 kilocycles throughout its Champaign coverage and on a frequency of 610 kilocycles in LAR. The 640 kilocycle frequency was chosen as the station's mai noperating spot since only one other radio station in the country operated on the same frequency. That station is KFI in San Francisco, California.

The station is a member of the Intercollegiate Broadcasting System, a nation-wide organization of similar non-commercial carrier current stations. It is also a member of the United Press Radio Service, which provides 24-hour teletype news' summaries for WPGU's two daily 15-minute news programs.

Tom Simpson, electrical engineering senior, is the station manager of WPGU. Other administrative officers are Bill Bailey, political science junior, assistant station manager; Mickey Klein, liberal arts sophomore, program director; and Anderson, chief engineer.

Working together with their staff, these University students hope to expand WPGU's operations, improve the quality of service, and increase its coverage.

WPGU represents a prime example of what the combination of student ingenuity and hard work can produce.

Have you heard about the illegitimate Rice Krispy? Snap, crackle and no pop!

* * *

Bars are something which if you go into, you are apt to come out singing a few of, and maybe get tossed behind.

* * *

Coed to fraternity boy: "Let's walk home. I'm too tired to get into a cab with you."

* * *

If all the coeds in the world who didn't neck gathered in one room what would we do with her?

* * *

Asked how he achieved such natural, delicate flesh tints on his nudes, the painter Renoir is said to have replied:

"I just keep on painting and painting until I feel like pinching—then I know it's right."

* * *

Selectee: "They can't make me fight."

Draft Board: "Maybe not—but they can take you where the fighting is and let you use your own judgment."

* * *

"They tell me your wife is outspoken."

"By whom?"

* * *

A good speech is like a girl's skirt, it is long enough to cover the subject, and yet short enough to be interesting.

* * *

Mary had a little plane
Thru the skies she frisked.
Wasn't she a silly fool.
Her little * ???

* * *

Dear Pop:

Everything fine at school. I'm getting lots of sleep and am studying hard. Incidentally, I'm enclosing my fraternity bill.

Your son, Pudge.

Dear Pudge:

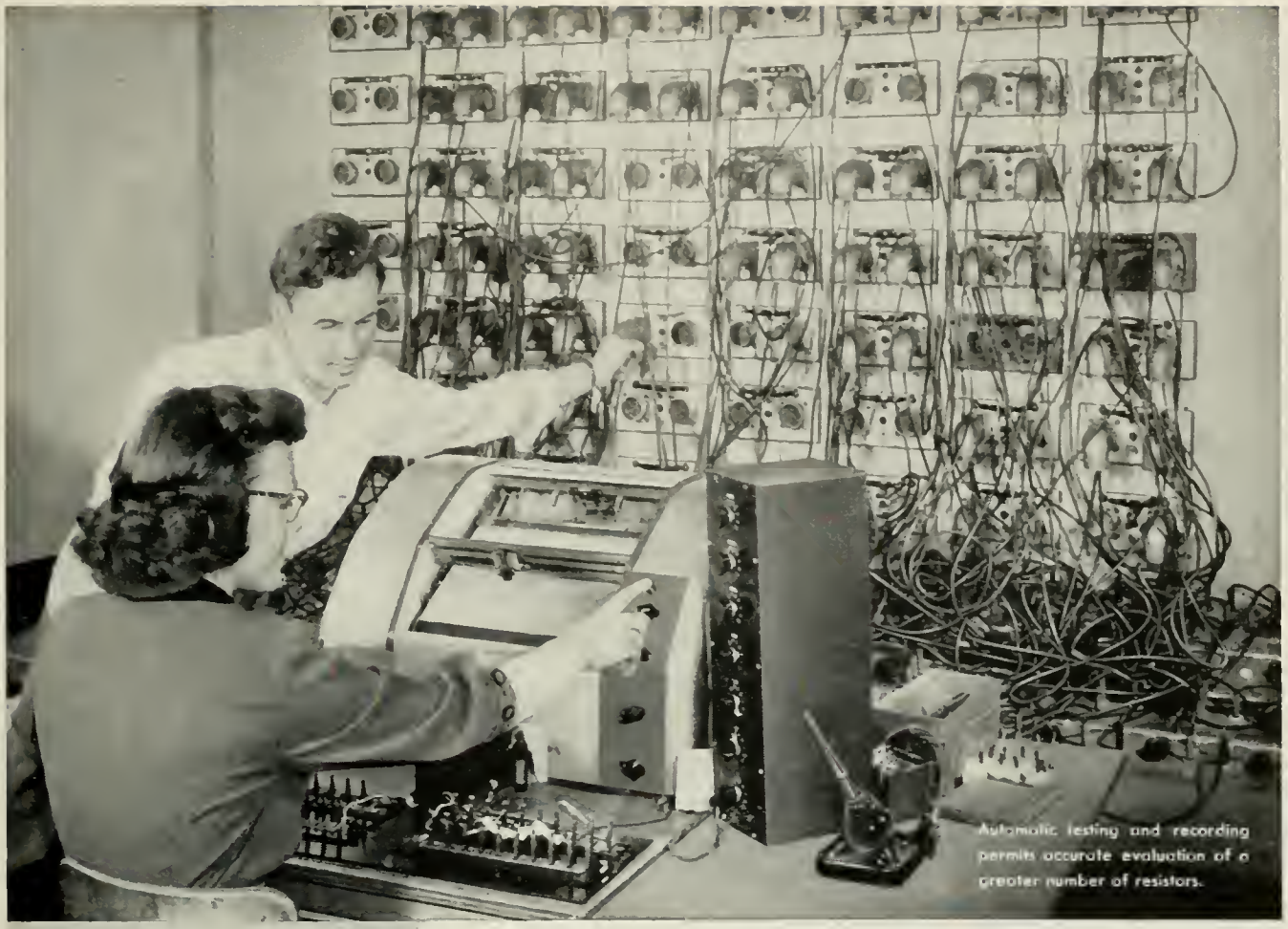
Don't buy any more fraternities.

Your Pop.

* * *

Several weeks ago, coming home from work on a crowded bus, I stood next to a woman and her small son. I asked her if she wasn't afraid the little boy would be crushed.

"Not at all," she answered. "He bites."



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MIL-R-11A Specification

IRC Power Wire Wound Resistors
MIL-R-26B Specification

Type BW Low Wattage Wire Waunds
JAN-R-184 Specification

Sealed Precision Voltmeter Multipliers
JAN-R-29 Specification

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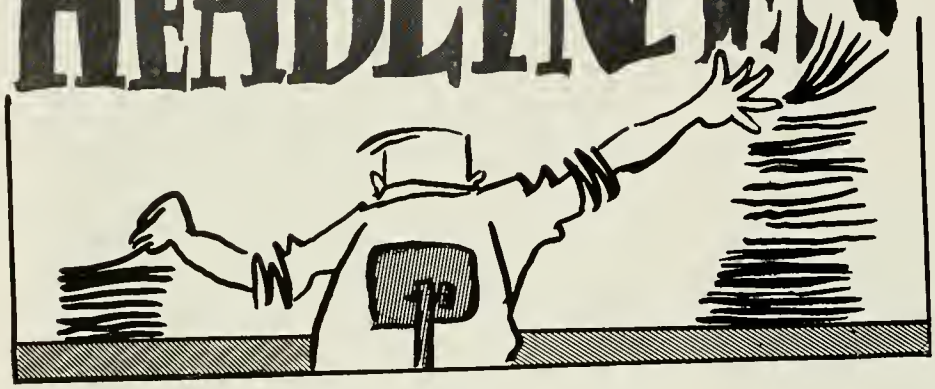


by Larry Kiefling, M. E. '56

New Sabre

A sixth model of North American Aviation's famed Sabre Jet series, the F-86K, has been ordered by the U. S. Air Force, the company announced today.

An all-weather jet fighter, the new Sabre Jet is actually a cannon-firing version of the F-86D, the nation's first and only one-man jet interceptor and twice holder of the official world speed record. The new Air Force contract calls for an undisclosed number of "K's." The planes are being procured by the Air Force with Mutual Defense Assistance Program funds for delivery to NATO countries.

The Air Force has just ordered the sixth revised model of the all-weather Sabre Jet series. The main difference was increased armoment.

The new fighter is almost identical in appearance to the rocket-firing F-86D, except for an addition of eight inches to the length of the fuselage. Its chief difference is armament, which consists of four 20-mm cannon instead of the 24 "Mighty Mouse" rockets carried by the interceptor.

The additional eight inches in the fuselage was necessary to re-balance the new plane due to the shift in position of the armament.

Along with its new firepower the F-86K is equipped with a new automatic fire control system designed to enable the pilot to shoot down enemy planes even at night or in murky weather.

The first flight of the prototype F-86K fighter was made on July 15 at Los Angeles International Airport. Engineering Test Pilot Ray Morris, who stayed aloft for 30 minutes on the initial hop, described "a perfect flight" upon landing.

"This is unusual for a new airplane," the veteran test pilot said. "We usually find a couple little things, but not today."

When asked about speed Morris reported, "It goes just like the 'D'!"

Like its rocket-firing cousin, the F-86K is powered by the General Electric J-47-33 turbo-jet engine, rated at 5,600 pounds thrust plus afterburner. This puts the new fighter in the "over 650 m.p.h." speed class, as is the F-86D. Its combat radius is listed as approximately 500 miles.

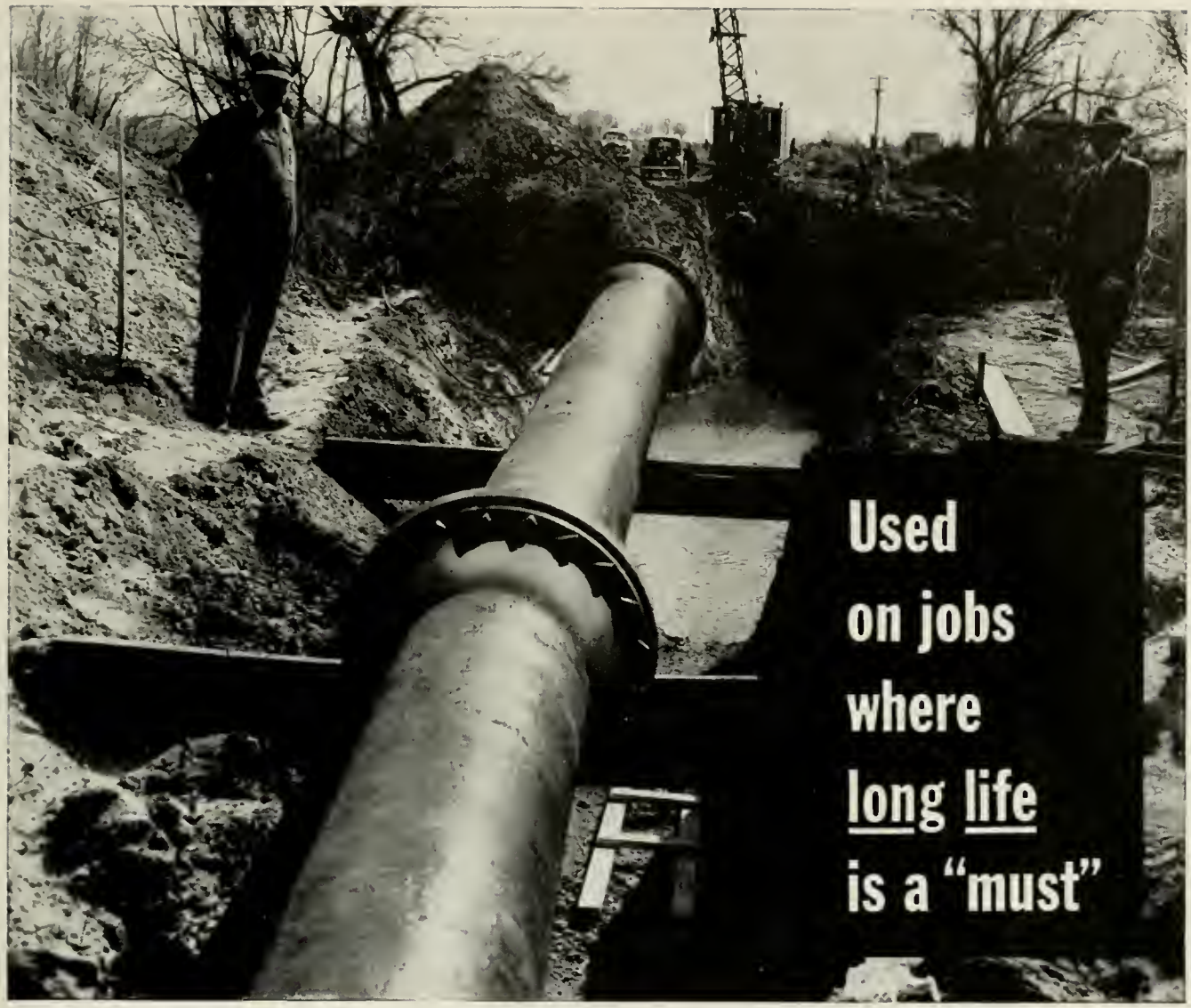
Also incorcorporated into the 35 degree swept wings of the F-86K are the aerodynamically actuated wing leading edge slats for high lift and improved low speed handling characteristics. Like all later models of the Sabre Jet the new fighter is equipped with the famed "all-flying tail," in which the entire horizontal stabilizer is moved for control, and hydraulic power-operated irreversible controls with artificial "feel" for the pilot.

As in later models of the F-86D, the F-86K is equipped with a parabrake for aid in landing on short or slick runways.

Electronic Research

Teamwork in electronic research and development should be emphasized while the electrical engineer is still in college, a New York University professor said today (Friday, June 18) at the annual meeting of the American Society of Engineering Education.

"Since so much of the research and development work in electronics today



Installing cast iron mechanical joint pipe across river at Salina, Kansas, for sewer main.

When an installation, once completed, should be as trouble-proof as planning and materials can make it — engineers rely on cast iron pipe. It has high beam-strength, compressive-strength and shock-strength. Its effective resistance to corrosion ensures long life, underground or underwater. These are reasons why cast iron pipe is so widely used for water lines in tough terrain, pressure and outfall sewers, river crossings, and encased piping in sewage treatment and water filtration plants. Cast Iron Pipe Research Association, Thos. F. Wolfe, Managing Director, 122 So. Michigan Ave., Chicago 3, Ill.

This 123-year-old cast iron water main is still in use in the distribution system of St. Louis, Mo.

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KRANE KAR handles steel stock and forms of any shape or size within capacity (or scrap when equipped with magnet); transmission cases, motors, crankcases, transformers, etc. Works in tight quarters, low headroom, up and down ramps . . . anywhere, in plant or yard. Often cuts handling costs to 8¢ a ton.*

Safest Crane in its class, minimizing injury risks to men, materials, machine. ***Self-Stabilizing:*** dangerous use of jacks or stabilizers eliminated. ***Automatic Power Cut-Off*** at extreme positions of Boom-Swing or Topping. ***Automatic Braking*** of Load and Boom Lines. ***No Tail-Swing:*** no part of Crane passes over operator's head.

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Below Right: Three of the six Frick refrigerating machines in service at Big Spring, Texas.

New Phillips Product

New Application of FRICK Refrigeration

Phillips Chemical Company's new plant near Big Spring, Texas, is the first in the country to produce 98% pure para-xylene (used in the manufacture of a synthetic fiber) in commercial quantities.

The new, revolutionary process, patented by Phillips, involves continuous fractional crystallization. The heart of the system is a Frick "cascade" low-temperature refrigerating plant that FREEZES OUT para-xylene crystals.

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The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, offers a career in a growing industry.

done by teams of men, rather than on a lone wolf basis," declared Professor James H. Mulligan Jr., "students (seniors in particular) should be given experience in working together for extended periods of time on involved laboratory exercises or student projects." Professor Mulligan is chairman of the department of electrical engineering at NYU's College of Engineering.

"If a student's efforts can be guided in such a way that he learns to reason and analyze as an individual, and yet is also given some idea of the strength and effectiveness of a cooperative work group whose members respect one another's contributions, he will be much better prepared to progress in a professional assignment upon graduation," the educator noted.

Discussing the possibility of granting "special designations" to schools whose standards in electrical engineering are higher than the minimum set by the ASEE, Professor Mulligan said "the real test should be made on the basis of what is really accomplished with the students," not simply on the stated course of study and the qualifications and abilities of the faculty.

He suggested that if "special designations" were to be made, a national committee of recognized scientific leaders in the electronics fields from industry, government, and the teaching profession would be the appropriate evaluating group. He said the best test of an engineering college's performance would be an examination of students near the end of the senior year, which would include comprehensive personal interviews and a study of final examination papers and laboratory reports. Professor Mulligan proposed five standards:

1. Competence in the oral and written expression of ideas.
2. Mastery of the mathematics prescribed for the professional-scientific curriculum.
3. A broad understanding of the manner in which the various areas of electrical engineering combine to form the whole.
4. A detailed knowledge of electronic circuit analysis.
5. An ability to analyze and solve problems that involve the application of several electrical engineering and physical concepts to obtain a single result.

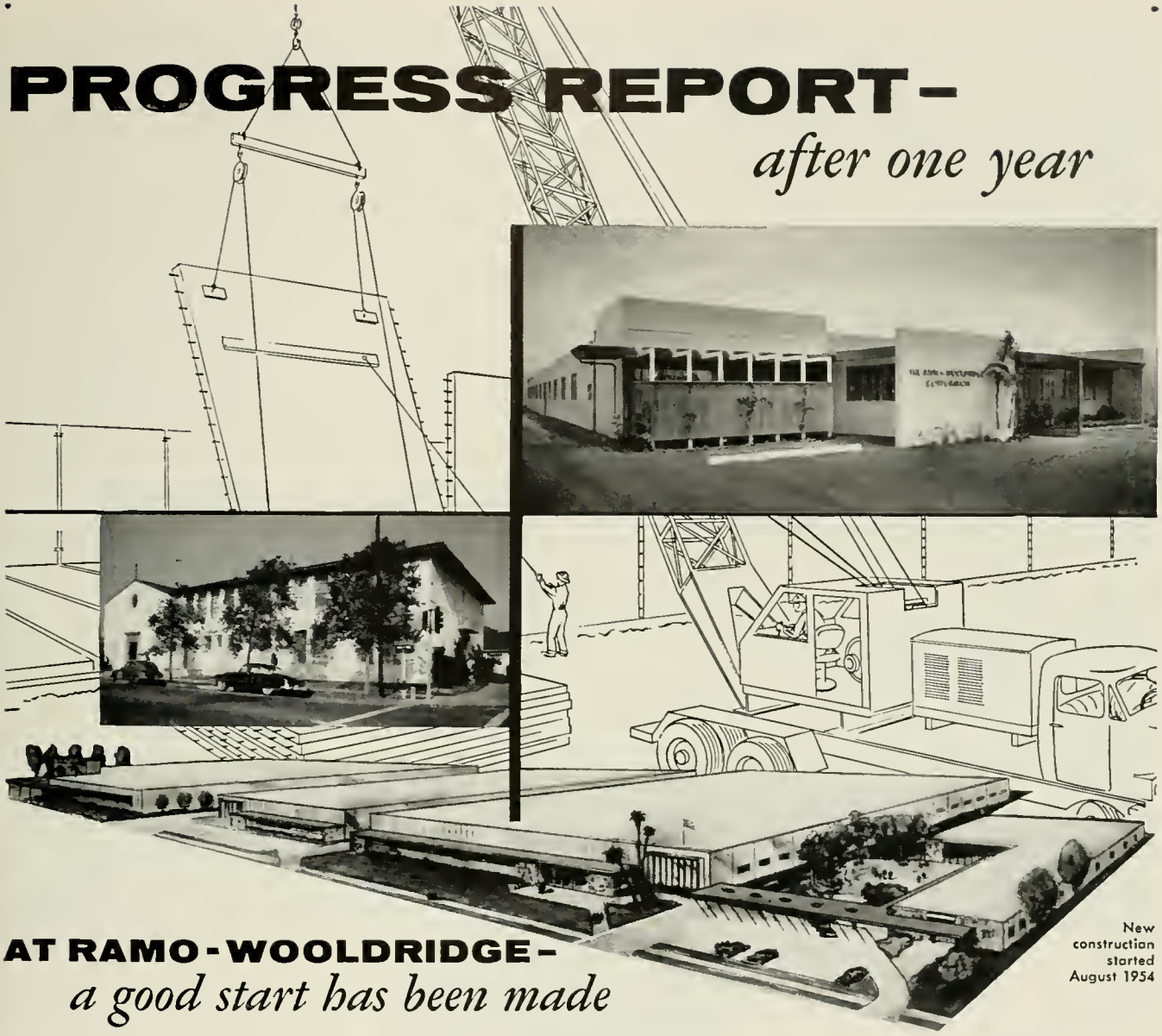
If the mechanics of evaluation render it impractical for the ASEE to grant special designations, the review would nevertheless provide an institution with "an extremely realistic view of its effectiveness," Professor Mulligan declared.

The competent teacher of electrical engineering, Professor Mulligan said, should have a combination of theoretical training and enough industrial experience to have developed practical judgment important to the effective practice of the profession. The NYU educator recommended that the following criteria be applied to members of faculties that would receive special designations: qualification for the higher grades of membership in the American Institute of Electrical Engineers and the Institute of Radio Engineers, work on professional society or industry committees, and publication of technical papers.

Emphasis should be on quality rather than quantity of published efforts, he stated. The teacher should be "well versed in transient circuit analysis; in linear network theory, both feedback and nonfeedback; and in some of the graphical and mathematical methods used in the analysis of nonlinear systems." Furthermore, "he should have achieved what is usually called 'mathematical maturity', having a good working knowledge of Fourier, Laplace, and similar transform methods, functions of a complex variable, and series expansions."

Professor Mulligan pointed to reduced teaching loads, smaller classes, outside assignments beginning with the freshman year, and education methods for self-teaching after graduation as further means of improving electrical engineering education.

PROGRESS REPORT—
after one year



New construction started August 1954

AT RAMO-WOOLDRIDGE—
a good start has been made

Progress during a new company's first year can be measured in terms of plant and equipment, contract back-log, or quality and quantity of personnel.

By any of these standards the first year's experience of THE RAMO-WOOLDRIDGE CORPORATION has confirmed the soundness of the basic theses on which the company was established:

1. Competence in systems analysis, engineering and development, a relatively scarce commodity, is one of the most salable articles in America today.

2. Scientists and engineers find unusual satisfaction in participating in the development of a company in which, from the outset, all features of the organization and of the operational procedures are designed to be as appropriate as possible to their special needs.

Today, research and development activities are being conducted by an organization of approximately two hundred people, which will more than double within twelve months. Urgent project responsibilities have led to the temporary use of such quarters as the former school and church shown in the photograph, but construction is complete on 20,000 and well along on an additional 80,000 square feet of the 200,000 square foot permanent laboratory building program. Orders have been placed for $1,500,000 worth of digital and analogue computers that will be installed the end of this year to facilitate the extensive analyses required by current projects.

In the light of the first year's progress THE RAMO-WOOLDRIDGE CORPORATION anticipates expanding opportunities to perform major research, development and—a little later—manufacture in the fields of commercial and military electronic systems, and in guided missiles.

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Guided Missile Research and Development

Digital Computer Research and Development

Business Data Systems Development

Radar and Control Systems Development

Communication Systems Development

Pockmarked Windshields

Pitted automobile windshileds are the result of normal wear, not the work of the H-bomb, cosmic rays, industrial sediment, or Martians.

That is the view of scientists who have been studying recent cases of "pockmarked" windshields in the Chicago area.

Talk about H-bomb effects merely has made people more observant about marks on their windshields, explained John Krc Jr., research crystallographer, and Dr. Walter C. McCrone, senior chemist, both of Armour Research Foundation of Illinois Institute of Technology, Chicago.

The scientists based their observations on the examination approximately 25 samples of shattered and pitted windshields submitted for analysis by Chicago area motorists.

"We found the marks in nearly every case to be similar and several months old," Krc said. "There was no evidence that the damage was the result of radioactivity, cosmic rays, air rifles, or other such causes."

Gravel, dirt, or stones accounted for every particle scraped from the holes, they said.

McCrone and Krc do not believe new curved front windshields are more susceptible to flying gravel than older types.

"But when a curved rear window is hit, it may disintigrate more completely than a flat window," McCrone said.

The "mysterious" honeycombing of some of the glass samples apparently was caused by the same thing that produced pitting—stones thrown up by cars, according to the examinations.

Rear windows showed honeycombing, while front windows were pitted, the scientists explained.

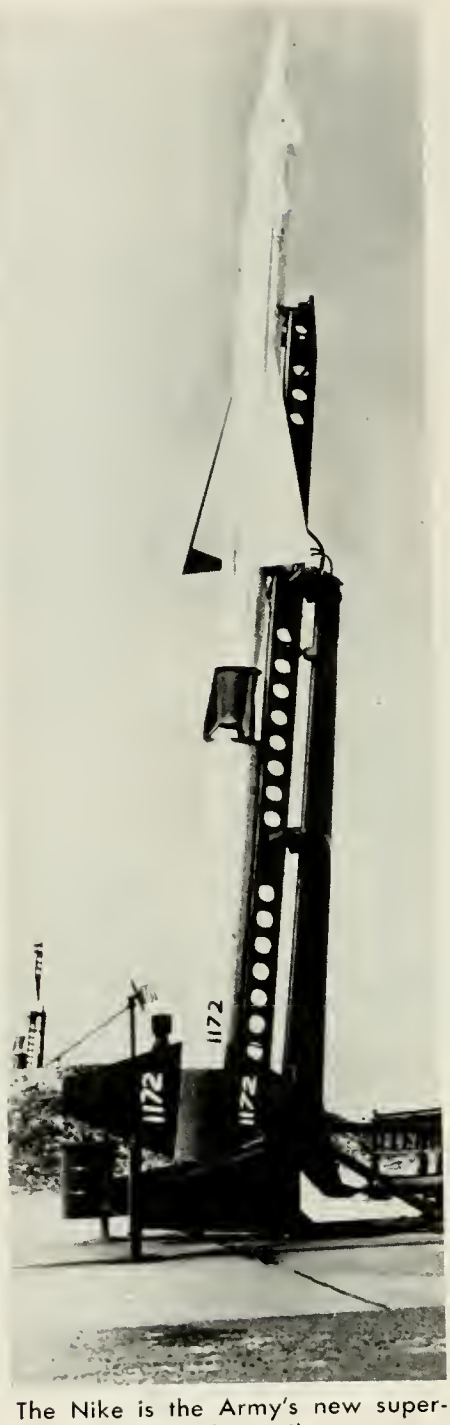
Rear car windows usually are made of tempered glass purposely strained in construction to give structural strength. When the surface is broken, they said, the strain is released and the window disintegrates into a cobweb pattern.

Front windows, however, are laminated with plastic as a safety feature to prevent this. When these are hit the glass is likely to show pits rather than honeycombing, they added.

Nike

Consisting of more than 1,500,000 individual parts, the dramatic Nike, with its approximately 300 highly complex electronic "brain cells," is the first surface-to-air guided-missile system to be put into service around U. S. cities.

Nike is the answer to Army Ordnance's call for a new defensive weapon that will meet an aerial target in its own element and on its own terms. Such a weapon had to be highly maneuverable throughout its flight. And matching speed with speed would not be sufficient, since the initiative would remain with an enemy plane.



The Nike is the Army's new supersonic anti-aircraft missile.

The end product of eight years' guided missile research, Nike is the only supersonic anti-aircraft missile thus far announced that can follow and destroy an enemy target despite its evasive action. Essentially a defensive weapon, the Nike system is highly mobile and will work in any weather—even when visibility is zero. The system consists essentially of two parts: an expendable aerodynamic, liquid-fueled missile and the highly elaborate million-and-a-half part control network.

Named after the goddess of victory of Greek mythology, this fantastic new system and accompanying radar equipment is currently being mass produced.

Several large vans are needed to house the vast array of electronic equipment in the control system. Aside from the 20-foot missile and its booster rocket the other principal units included radars and launching equipment.

Fatigue Tester

By determining the load that can be applied repeatedly to steel samples without causing failure, detailed information on how to build and fabricate greater safety into steel conveyances and structures will be available from the new research center now under construction near Pittsburgh, Pennsylvania. Such research into the endurance limits of steels makes it possible for engineers to design within safe limits without excessive weight or waste.

One of the machines now being used for such research is a magnetic fatigue tester. Samples of steel from 24 to 36 inches in length and up to 2 inches thick and 5 inches wide can be subjected to controlled vibrations at the natural frequency of the test piece.

The machine consists of two rubber-padded supports upon which the test piece is placed, an electro-magnet located at each end of the tester, pick-up coils located at the center of the sample, a power unit with controls, a stroboscopic light, and a micro-comparator to measure vibration amplitudes.

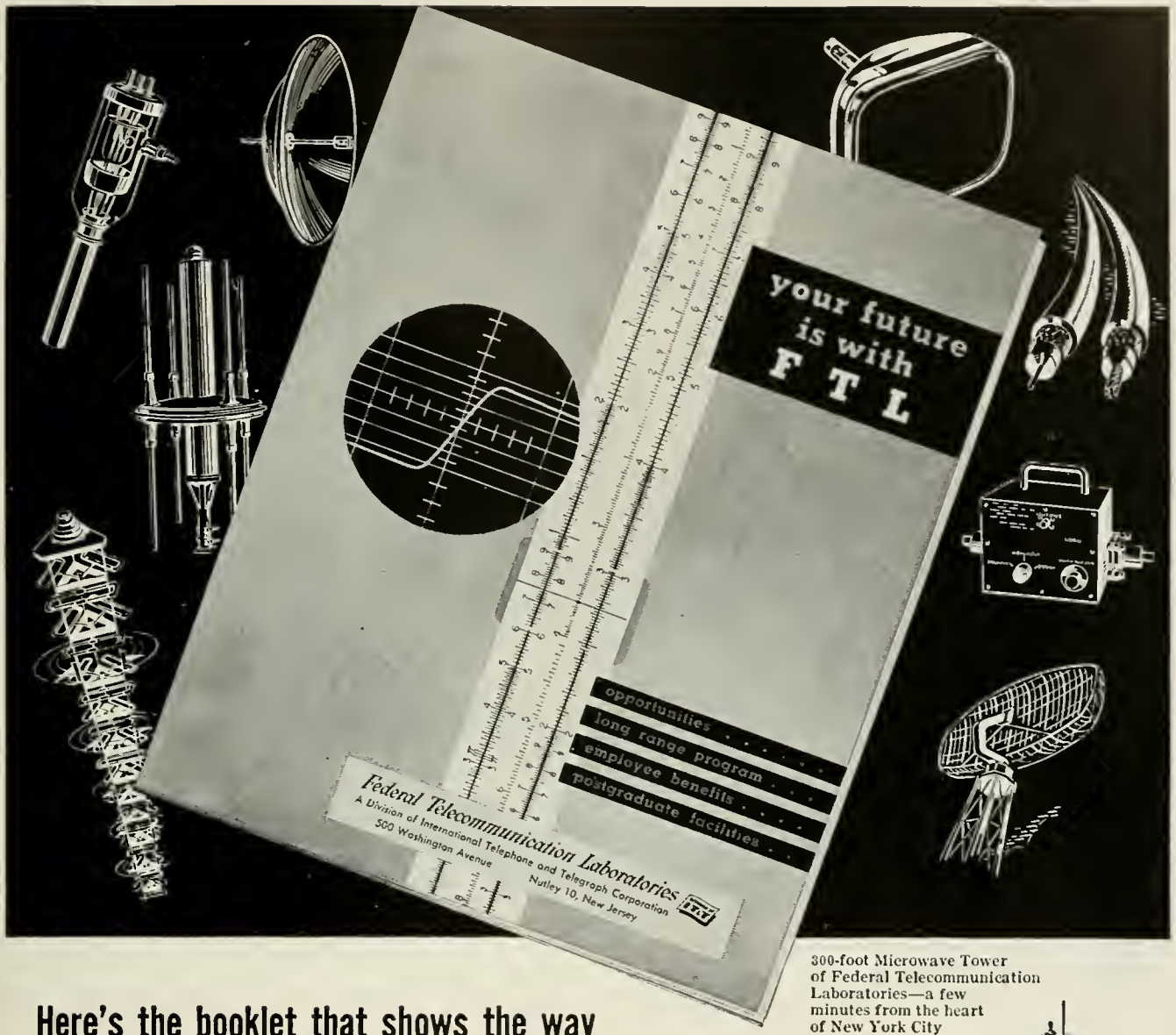
A piece of steel, which must be long enough to extend over the two end magnets, is placed on the ruhber-padded supports and the end magnets are positioned under the ends of the sample. An alternating current is then supplied to the end magnets to set the steel vibrating, much after the fashion of a tuning fork.

Each experimental section has a natural frequency at which it will vibrate the natural frequency depending on the dimensions of the piece. The center pick up coils translate the motion into electrical impulses which feed back to the power unit at the natural frequency of the sample. These impulses control the pulsations of electricity from the power unit to the end magnets so they match the frequency of the specimen and keep it vibrating.

The amplitude of the sample's vibrations depends on the intensity of the current supplied to the end magnets.

When a crack develops in the test specimen, its natural vibrational frequency changes. This change upsets the rhythm of impulses from the pick-up coils to the power unit and the machine automatically stops.

By use of the micro-comparator, the



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The company's origin dates to 1899. In many American industries a half-century old is considered a newcomer; but in alkali manufacture, that age indicates pioneering.

Columbia-Southern is a wholly-owned subsidiary of the Pittsburgh Plate Glass Company, but its operation—sales, research, engineering and plant administration—is entirely separate. Sales to Pittsburgh Plate Glass represent only a minor portion of the company's total volume.

Columbia-Southern thus combines the advantages of independent operation as a corporation of moderate size with the greater stability which comes from being a part of a larger, more diversified organization. Individuals are not "lost in the crowd" at Columbia-Southern. Employment stability is high and the company's ability to grow is virtually unlimited.

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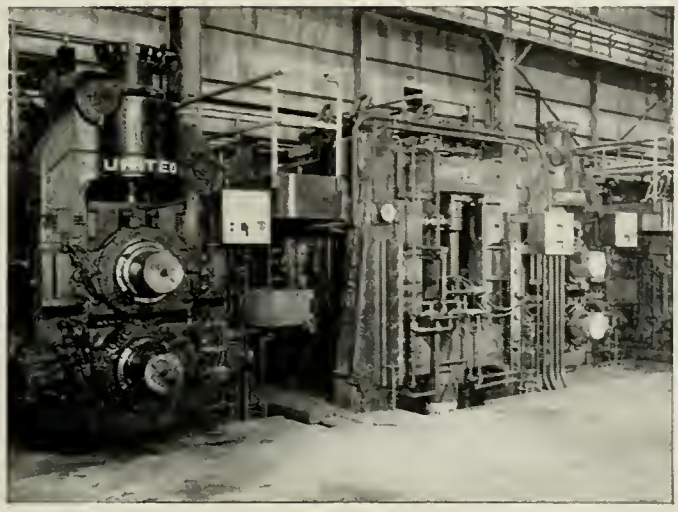
Another page for **YOUR BEARING NOTEBOOK**

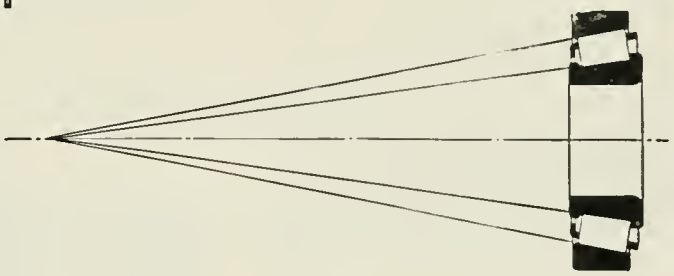


How billet mill gets extra bearing capacity in same space

Engineers who designed this 10-stand billet mill specified that the roll necks be mounted on Timken® Balanced Proportion bearings. That's because Timken Balanced Proportion bearings have load ratings up to 40% higher than same-size bearings of older designs. And they make possible a 50 to 60% increase in roll neck strength which means greater rigidity and higher rolling precision.

True rolling motion, high precision practically eliminate friction

All lines drawn coincident with the working surfaces of the rollers and races of Timken bearings meet at a common point on the bearing axis. This means Timken bearings are designed to give true rolling motion. And they are precision manufactured to live up to their design. Result: Timken bearings practically eliminate friction, save power.



TIMKEN
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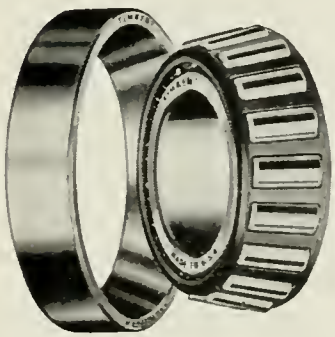
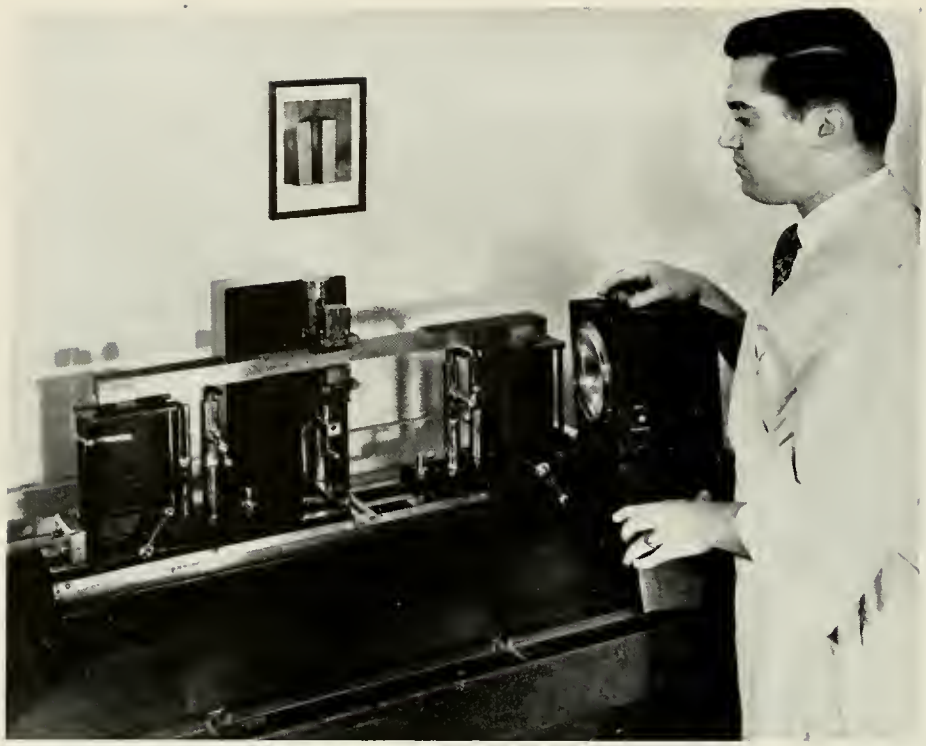
TAPERED ROLLER BEARINGS



Want to learn more about bearings or job opportunities?

Many of the engineering problems you'll face after graduation will involve bearing applications. For help in learning more about bearings, write for the 270-page General Information Manual on Timken bearings. And for information about the excellent job opportunities at the Timken Company, write for a copy of "This Is Timken". The Timken Roller Bearing Company, Canton 6, Ohio.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◎ AND THRUST ⊣◎⊢ LOADS OR ANY COMBINATION ✳



The operator of this fatigue tester hos his hands on the stroboscopic light which determines the location of very small fatigue cracks.

research scientist can easily measure the amplitude of the vibration or the amount of bending.

The stroboscopic light is used to establish the location of very small fatigue cracks. This is done by adjusting the light from the stroboscope to a frequency slightly higher or slightly lower than that of the vibrating sample. In this light, the test piece appears to be bending very slowly and its surfaces can be carefully examined for very small cracks.

A test sample about ¾-inch thick by 3 inches wide by 30 inches long will vibrate at about 100 cycles per second. Middle C in the diatonic scale is 256 cycles per second and C below middle C is 130 cycles per second or almost 8,000 per minute. Past experience and innumerable tests have proven that if a specimen can endure 10,000,000 cycles at a certain amplitude without failure, it will withstand an infinite number of vibrations at that amplitude.

If a structural component is desired with a minimum of 20,000 pounds per square inch endurance limit, the research scientist can very quickly determine on the magnetic fatigue tester what steels will meet the requirement. Resistance to fatigue failure is important to insure a safe design.

Through the application of the results from such tests on steels for aircraft, bridges, and other applications in which cyclic loading occurs, engineers can design lighter and safer structures. The machine also makes possible the determination of the fatigue limits of steels with various surface finishes and with welds, rivets, and other fastenings.

Air Gauge

A new Adjustable Airebore Gage Kit with a 3" to 12" range of adjustment has been announced. With this kit, any size hole between 3" to 12" in diameter can be quickly and accurately inspected for size, taper, and out-of-roundness.

The gage consists of a triangularly shaped spindle body to which are mounted a Plunget gaging cartridge, and these interchangeable components: centering foot, handle connector, length extensions, and adjustment screw. All contact surfaces are of tungstein carbide. The Plunget gaging cartridge, connected to a column type Precisionaire provides 1000 to 1 amplification.

The Adjustable Airebore gage is light in weight, quickly adjusted, and easy to use. It does not require Master Setting Rings, as it is set to the diameter being gaged with gage blocks and a 0" to 12" Calibrator. The gage is self-centering and needs only to be rocked to ascertain the true diameter of the bore.

"Ah wins."
"What yo' got?"
"Three aces."
"No yo' don't. Ah does."
"What yo' got, Bo?"
"Two eights and a razor."
"Yo' sho' do. How come you' so lucky?"

* * *

A girl and an engineer were listening to a chime recital.
"Beautiful, aren't they?" said she.
"Pardon?" he inquired.
"I say, they're beautiful, aren't they?"
"I'm sorry," he roared, "but I can't hear a thing except those lousy bells."

With this Adjustable Airebore Gauge Kit, ony size hole between 3" to 12" in diameter con be easily inspected for size, toper, and out-of-roundness.

The hotter...the better

Carbon has a peculiar quality—it's at its best when "the heat is on"

IN THE ROARING HEAT of steelmakers' furnaces, molten metals boil and bubble like water in a teakettle.

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Because pure carbon laughs at heat—actually grows stronger as it gets hotter—it has become vitally important in making iron, steel, and many of the other things all of us use every day.

IN CHEMISTRY, carbon and its refined cousin, graphite, handle hot and violent chemicals that would quickly destroy metal or other materials. Today there are pumps, pipes, tank linings, even entire chemical-processing structures—all made of carbon or graphite.

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put in extra effort toward building a better job for
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schedule on your campus and ask for referral to . . .

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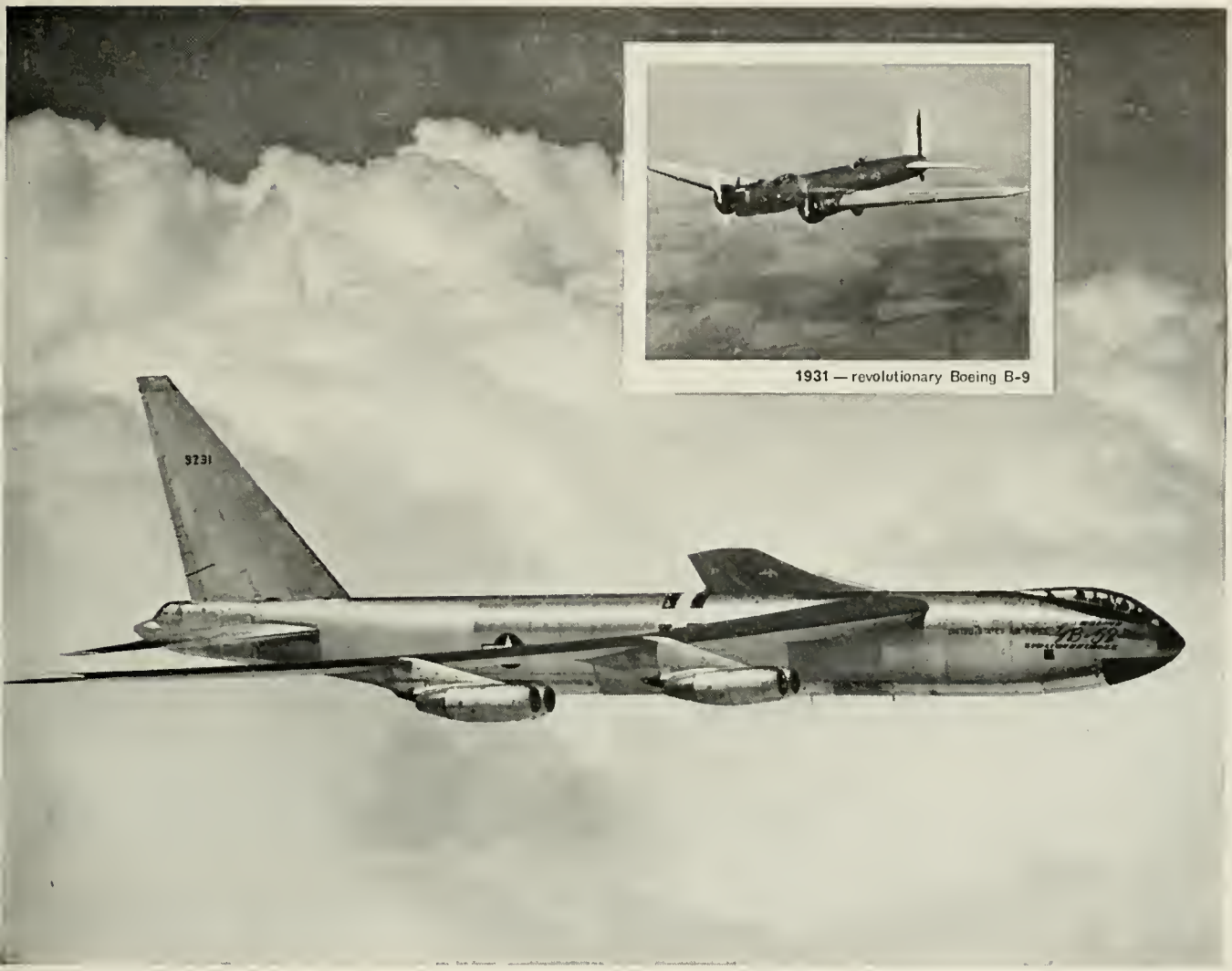


1931 — revolutionary Boeing B-9

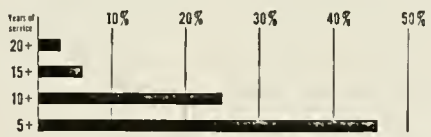
1954 — Boeing 8-jet B-52, America's outstanding heavy jet bomber

Leadership is a long-time tradition at Boeing

In 1931, Boeing engineers designed the B-9, a revolutionary low-wing bomber that could outdistance any contemporary pursuit plane.

Today, they've produced the free world's outstanding heavy jet bomber, the B-52, and America's first jet transport. Boeing also builds the record-breaking B-47 medium jet bomber, conducts a major guided missile program, and research in nuclear power for aircraft.

These growing programs mean expanding opportunities at Boeing for engineers of virtually EVERY type, including mechanical, civil, electrical and aeronautical. It also means plenty of room for advancement. Boeing, which now employs more engineers than even at the peak of World War II, promotes from within, and holds regular merit reviews to give you individual recognition.



As the chart shows, 46% of Boeing's engineers have been here for five years or more; 25% for 10 years; and 6% for 15 years, and many have been with the company 25 years or longer.

Boeing offers engineers an unusual variety of experience, from applied research to production design, from work with new materials and techniques to co-ordination of a vast subcontracting program which provides contacts with a cross-section of U. S. industry.

Boeing also helps engineers continue their graduate studies, and reimburses them for tuition expenses.

For further Boeing career information, consult your Placement Office, or write:

JOHN C. SANDERS, Staff Engineer—Personnel
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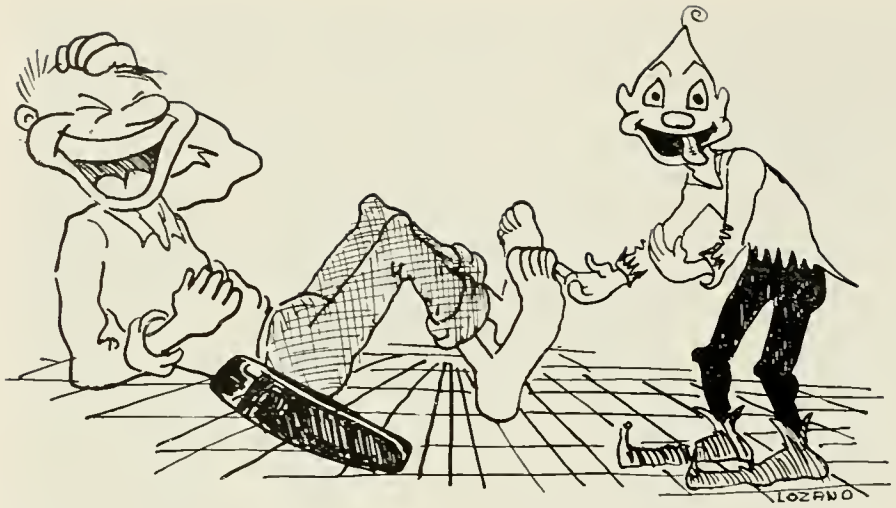


TECHNOCRACKS

A traveling man on a business trip to the city boarded the sleeper and pulled back the curtains to his berth. He was extremely surprised . . . to find two most personable blondes ensconced there.

After checking his ticket to see that he wasn't wrong, he said, "I deeply regret this, ladies, but I am a married man . . . a man of respect and standing in my community. I couldn't afford to have any breath of scandal touch me. I'm sorry—but one of you will have to leave."

* * *

Drunk—"Believe it or not, ofisher, I'm looking for a parking placesh."

Cop—"But you haven't got a car."

Drunk—"Yeah, I have. Itsh in the parking placesh I'm looking for."

* * *

The draft board doctor was examining a prospective recruit.

"Read that chart," he commanded.

"What chart?" asked the draftee.

"That's right," said the Doc, "There is no chart, you're in, boy!"

* * *

ROTC Sergeant: "Does your uniform fit satisfactorily?"

Frosh: "Well, the jacket is okay, Sir, but the pants are a bit snug under the armpits."

* * *

The bandaged CE who lay in the hospital bed spoke dazedly to his visiting pal.

"Wh-what happened?"

"You absorbed too much last night, and then made a bet that you could fly out the window and around the block."

"Why didn't you stop me?" screamed the beat-up student.

"Stop you hell," said the other. "I had $25 on you!"

Speaking of girls . . .

When one is mentioned here are some of the things the boys want to know:

Fine Arts student: "What play has she seen?"

Business student: "Is she the business type?"

Journalism student: "What did she ever write?"

The Engineer: "Where is she?"

* * *

Daffy Definitions

Bacteria: Rear of a cafeteria.

Bore: A chap with flat feats.

Charlatan: A medical quacktitioner.

Father: The kin you love to touch.

Garbage: Eatables smelled backwards.

* * *

GEOMETRICAL LOVE

Given: I love you.

To Prove: You love me.

Proof: I love you (given).

Therefore, I am a lover.

All the world loves a lover. (Axiom)

You're all the world to me. (Constant)

Therefore, you love me.

* * *

The big day was here. The wonderful new bridge connecting the country's largest cities was being formally opened. At the height of the festivities, when thousands of people were massed at the middle of the bridge, the center span gave way, and it fell into the river with a thunderous roar. The chief engineer turned to his assistant and asked, "Where the hell did you put that decimal point?"

* * *

During the observance of Animal Week, the fourth graders told about their kindnesses to pets. Asked what he had done, one little boy said: "I kicked a boy for kicking his dog."

There is a great difference between the right word and one that is similar but all wrong. For instance, you can call a woman a kitten, but not a cat; a mouse, but not a rat; a chicken, but not a hen; a duck, but not a goose; a vision but not a sight.

* * *

Have you heard about the M. E. who walked through the screen door? He strained himself.

* * *

Man: A creature who buys football tickets three months in advance and waits until Christmas Eve to do his gift shopping.

* * *

A recession is a period in which you tighten your belt. A depression is a time when you have no belt to tighten. When you have no pants to hold up it's a panic.

* * *

An English journalist was traveling in a small South American country when one of their frequent revolutions broke out. "Why is it," he asked a native "that you people have so many revolutions here?"

"It's perfectly obvious," was the reply, "it's because so many of us haven't been president yet."

* * *

Papa Robin returned to his nest and proudly announced that he had made a deposit on a new Buick.

* * *

I call my gal a discontinuous function because she has no limits.

* * *

Anyone who thinks he is indispensable should stick his finger in a bowl of water and notice the hole it makes when he pulls it out.

* * *

"If a drunk is Souse of the Border in Mexico, what is he in France?"

"Plaster of Paris."

* * *

Scotsman: (at riding academy) "I wish to rent a horse."

Groom: "How long?"

Scotsman: "The longest you've got laddie. There are five of us going."

* * *

And then there was the Arts student who let his M. E. roommate fix him up for a date with Allis-Chalmers.

* * *

For years the bum slept under bridges and in ditches. Then one day he switched to culverts and became a man of distinction.

* * *

Mary had a little lamb. Sad, but that's what happened to a girl who always allows her black sheep to pull the wool over her eyes.

PHOTOGRAPHY AT WORK—No. 11 in a Kodak Series

Illustration shows test of aircraft compass at United States Gauge, division of American Machine and Metals, Inc. A magnetic force, developed by the loops, pulls the compass card 30° off its normal heading. Then the force is released. The instant of release and the moment the compass recovers by 5° are both recorded on the film—become positive evidence of proper performance.

Wanted: an inspector with a split-second eye *—photography got the job*

A difference of 2/10ths of a second means the compass passes or fails. So the maker pits it against a stop watch—gets definite proof of performance with movies.

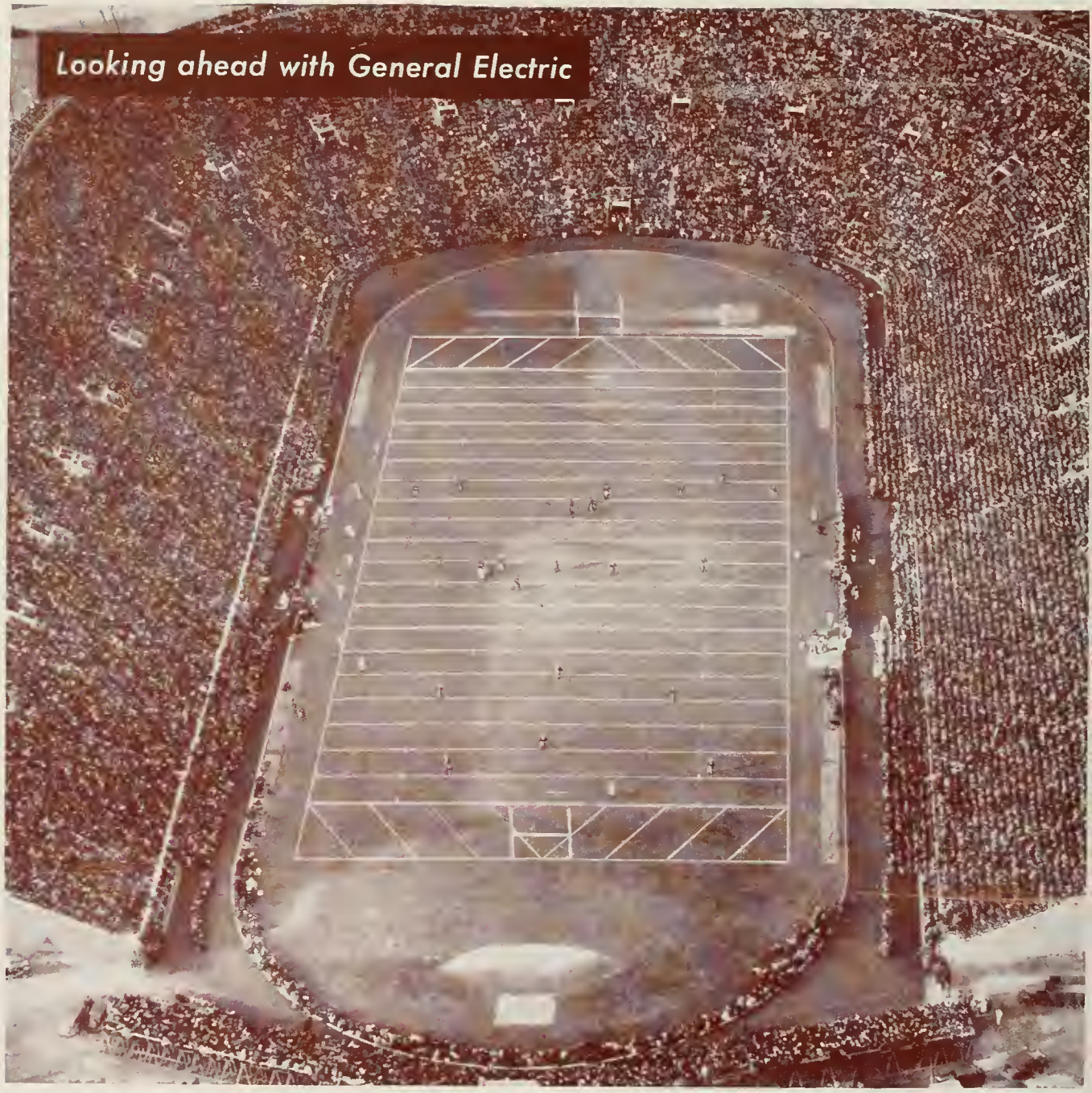
Uncle Sam said this aircraft compass must respond by 5 degrees in not less than 1 second or more than 1.2 seconds. That's only 2 10ths of a second leeway—far too little for human hands and eyes to catch the action accurately.

So, side-by-side, the stop watch and compass act their parts before the movie camera. Then individual frames along the film show the precise instant that the 5-degree mark is reached.

Product testing and quality control are naturals for photography. They are typical examples of the many ways photography works for businesses, large and small. It is improving production, saving time, reducing error, cutting costs.

Graduates in the physical sciences and in engineering find photography an increasingly valuable tool in their new occupations. Its expanding use has also created many challenging opportunities at Kodak, especially in the development of large-scale chemical processes and the design of complex precision mechanical-electronic equipment. Whether you are a recent graduate or a qualified returning service man, if you are interested in these opportunities, write to Business & Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.

Eastman Kodak Company, Rochester 4, N. Y.



45,000 G-E people working on jobs created by new products since 1945 could almost fill Princeton's Palmer Stadium.

In 9 years, new products created G-E jobs for enough people to fill a football stadium

Coming years promise even more progress.

One out of every five people at General Electric owes his job to products G.E. didn't make before 1945. And the future looks even brighter.

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As we see it at General Electric, America's industrial progress in a free economy is not only continuing, it's rapidly accelerating.

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ILLINOIS TECHNOGRAPH

DECEMBER 1954

25c

Robert L. Schneider, class of '49,
speaks from experience when he says...

"United States Steel offers unlimited opportunities covering practically all engineering fields"

IN 1949 Robert L. Schneider graduated from college with degrees in engineering and physics. After being interviewed by United States Steel, he was accepted as a trainee. Then after a year, he was advanced to a test engineer in the Maintenance Department; then to a power foreman in the Power & Fuel Division. By 1953, he had been made Power Superintendent in the Power & Fuel Division at the Carrie Furnaces.

As superintendent, he is responsible for the operation and maintenance of power producing and distributing facilities for the plant which supplies electrical power to several of our largest steel mills around Pittsburgh. Such advancement is not unusual at U.S. Steel.

As for the future, Schneider says, "Opportunities are unlimited. U.S. Steel is such a large and diversified organization that the future is not restricted to your current department or division. Transfer to equal or better positions in numerous other divisions is always possible."

To all future graduate engineers Mr. Schneider says, "U.S. Steel offers the best opportunity to get an overall picture of and experience in industry today. U.S. Steel is big enough to cover practically all engineering fields and permits a man to find the fields he wants to pursue."

If you are interested in a challenging and rewarding career with United States Steel and feel that you can qualify, you can obtain further details from your college placement director. Or we will gladly send you our informative booklet, "Paths of Opportunity," upon request. Just write to United States Steel Corporation, Personnel Division, Room 1628, 525 William Penn Place, Pittsburgh 30, Pa.

SEE THE UNITED STATES STEEL HOUR It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

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OIL WELL SUPPLY . . TENNESSEE COAL & IRON . . UNITED STATES STEEL PRODUCTS . . UNITED STATES STEEL SUPPLY . . *Divisions of* UNITED STATES STEEL CORPORATION, PITTSBURGH
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Start thinking today about a Caterpillar job. Representatives of the company will be on campus for interviews with interested students. Consult your placement office. Meanwhile, if you would like further information, write to Caterpillar Tractor Co., Employee Relations General Office, Box IL-1, Peoria, Illinois.

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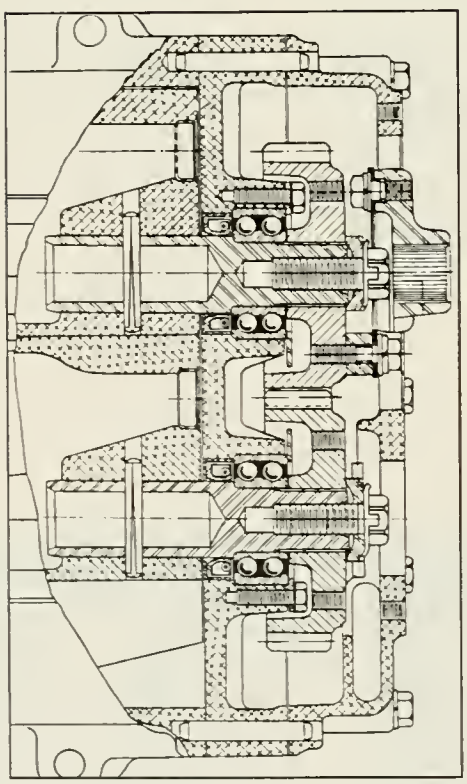

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our cover

The entrance of Bevier Hall. Women's physical education courses, mixed dancing classes and swimming classes are taught here. Home Economics headquarters is also located in Bevier Hall.

our frontispiece

This picture of a cupola was taken in the Foundry Lab at the University of Illinois. At the end of each heat the bottom doors on the cupola are opened to remove the remaining contents of the cupola.

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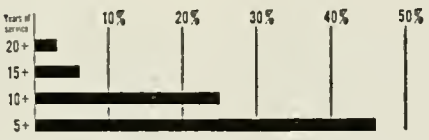

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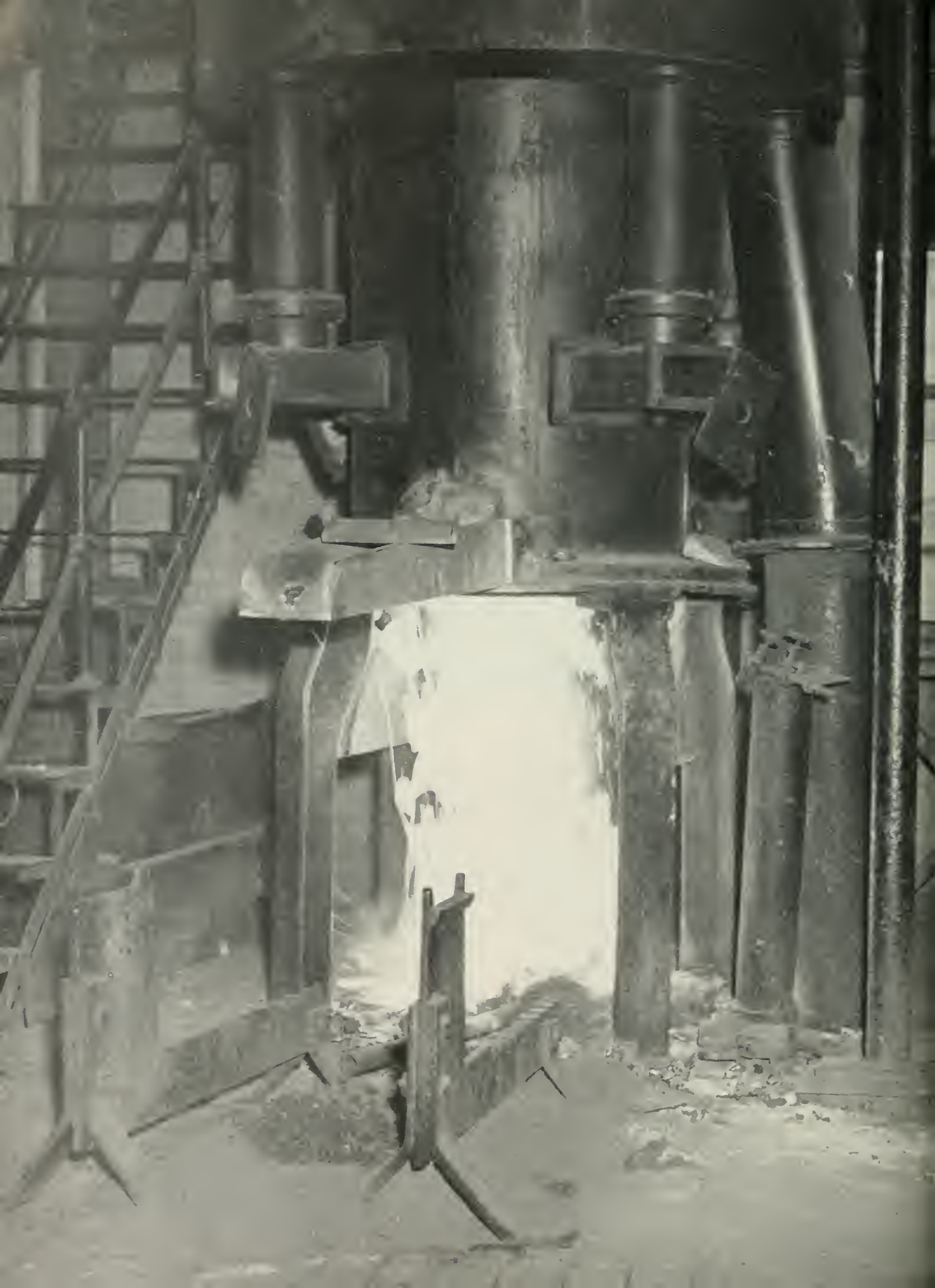

SYSTEM SAND CONTROL

by Norman E. Goelzer, M. E. '56

Sand control is as important to foundries as proper mechanization, especially to the Pacific Cast Iron Pipe and Fitting Company whose location necessitates large expenditures for Nevada sand. Their freight costs for these eastern silicon sands may run twice the price of the sand, itself. Along with sand control, the control of other parts of the system is necessary. Their system for complete control of production is based on the control of the component parts of the system and consists of core sand control, molding sand control, and equipment control. Also an extensive testing program and an inspection department help coordinate the component parts of the system. All the individual control processes help produce an efficient production with only a small per cent loss of castings.

The first important component of control starts in the core room. Two reasons for core room control are the sand from the cores becomes mixed with the molding sand, and good core room practice produces a high quality of castings. Therefore, core sand which will become molding sand should be of correct A.F.S. fineness and grain distribution to properly function as a molding sand. Actually, the sand is a molding sand that will work as a synthetic core sand. Other requirements for a molding sand to work successfully as a core sand are workability, sturdiness, porosity, and economy. The necessity for having the proper amount of core sand is important to constant control, since the addition of sand to balance the loss of molding sand causes irratic control. Still other factors that enter into cores are factors which pretains to core room practice. These are:[1]

1. Screen and measure (by weight or volume) all sands.
2. Keep core room equipment accurate and in good operating condition.
3. Make routine screen analysis tests to check the uniformity of the grain fineness and distribution of incoming sand.
4. Use the simplest mixture that will develop a core with adequate properties under controlled mixing conditions.

A (30-50 A.F.S. fineness) screen sand is used by the Pacific Cast Iron Pipe and Fitting Company as a compromise between the common sand used for cores and molding sand. For such a sand contains the desirable properties of flowability, lower oil consumption, and ease of venting.

The next important component part is control of the molding sand. The first important item is to have a large enough supply of sand to eliminate using hot sand (temperature above 110 degrees Fahrenheit) which will cause excessive moisture loss, stickiness, and poor workability. This requires a large storage space to carry on high production. The Pacific Cast Iron Pipe and Fitting Company have two fifty-ton storage bins to take care of the 1,400 lbs. of sand that are used every three minutes. The sand from the shake-out is stored in the bins where it is allowed to cool before going to the mullers. In the mullers the sand is mixed with one and three quarter pounds of western bentonite, one and three quarter pounds of southern bentonite, one pound of proprietory facing material, and the proper amount of wat-

Excess sand is struck off with a straightedge called a strike-off. The mold is then rented by being perforated with a rent wire. (Photo by Al Shiner)

er. These additives give the sand the following properties:[1]

	Mullers	*Hoppers*
Permeability	55-65	69-70
Green Compression, psi	9.0-11.0	10.0-12.0
Moisture, %	4.2-4.5	3.9-4.1
Hardness	82-86	85-90
Dry Shear, psi	25.0-30.0	20.0-25.0

These ingredients produce jolting, squeezing, raming, peen raming ability. Also the ability of the sand to retain the desired shape during handling, molding and moving. The sand system should be designed to help maintain these physical properties and uniform grain distribution. For an economical and efficient production the system should also be designed with simplicity, adequacy, and economy in mind.

Control of machinery and economical planning of the machinery used in the foundry are necessary for efficient production. Economical planning is necessary to eliminate over-mechanization which can cause financial loss, and it consists of determining whether certain equipment is desirable. This should be determined by first considering whether available equipment and facilities can be used with various modifications to eliminate the purchase of new equipment. The sand to metal ratio furnishes information to the efficiency of the foundry system. This can be calculated by dividing the weight of the sand by the weight of the metal poured minus the spures, gates, and the feeders. If the available equipment will not function efficiently then new equipment should be purchased.

The control of machinery is also very important. If one machine doesn't function propertly the efficiency of the whole system is impared for one part of the system will affect the rest of the system. Some examples of improper operation of the system are the following: a conveyor running to fast causing the molds to crack or to drop sand into the mold cavity, piping of the sand in the storage bin, plugged pipes on the dust collectors, missing or loose buckets on the elevators, to light or to severe a shake-out, muller plows set to high, poor hopper design, and slippage in the belt conveyors. To eliminate the various losses due to malfunctioning machinery rigid inspection and maintenance should be carried on at regular intervals. For example the items to be considered for a belt conveyor are:[1]

1. It should move at a rate that is within the specified range recommended by the manufacturer or designer.
2. Within the framework or adequate molding practice, it should not hold back full production.
3. The conveyor should move at a rate that will allow adequate pouring of the molds.
4. The conveyor starting, stopping, and movement should not damage the mold cavity.
5. The mold travel time measured from pouring to shake-out should be long enough to take the cooling castings safely below the critical range of temperature.
6. Proper regard should be given to the possibility of excessive sand heating especially when the sand to metal ratio is low.

After an efficient system is set up it is easier to fit the existing conditions instead of changing the system. For example, a certain casting has a defect which is due to porosity. This might be corrected by decreasing the ram instead of changing the amount of moisture or bond content of the sand. If the sand is changed to cure one defect, it might cause others to ruin the production of many more castings. To change ram might necessitate changing the setup of several molding machines or other items in the production line to provide more efficient production. Changes in pouring, molding, and gating are other things which will save making changes in the sand composition.

To keep a constant sand composition a rigid sand inspection is needed. A good example of what such a system should consist of is the system used by the Pacific Cast Iron Pipe and Fitting Company. The sand testing starts when the sand enters the plant in railway cars. Each car load has a sample taken from it and tested. The sand is also checked every two hours for permeability, green compression, moisture, hardness, density and dry shear. Also clay content, grain fineness and distribution, and total combustables are checked monthly. As soon as trouble appears these tests are repeated to find out what changes are necessary. For example if the sand becomes lumpy or shows signs of difficul shakeout the dry strength should be tested and any adjustments made. If the tests indicate that the dry strength is within the proper limits then other tests should be conducted.

The first check for defects is a visual check at the shake-out or in the bucket carrying the castings to the cleaning station. Any noticeable defects should be reported immediately so that proper adjustments can be made. The smaller and less noticeable defects are determined and classified by the inspection department. These defects are analyzed for the cause and eliminated by making the proper adjustments to either the equipment or molding and pouring procedures.

These combinations of sand control equipment control, and rigid inspection have proven very successful for the Pacific Cast Iron Pipe and Fitting Company in providing efficient production. These or similar methods could be incorporated in most foundries to produce low cost production.

Sand screening provides a smooth and even sand surfoce against the pattern surface. Therefore, a smoother casting is made.

[1]Morris Gittlman, "System Sand Control," *American Foundryman*, Nov. 1954. Page 56

Automotive
GAS TURBINES

by Siegmar Gresch, M. E. '58

Last June, the Chrysler Corporation revealed an automobile that may revolutionize the car of tomorrow—a Plymouth powered by gas turbines. Several countries in Europe have had turbine powered cars for three or four years now. But, Chrysler is the first to develop a device called a "heat exchanger" or "regenerator" which in one stroke wipes out two major barriers of the turbo car; it cools the exhaust gases to the extent that people behind the car will not be burned, and it enables the turbine car to get the same mileage as a piston-powered one. The basic design is still secret, but former cars threw away half their power in exhaust. This heat exchanger permits a cooler exhaust, and therefore attains higher efficiency. The designer, George Huebner Jr., a young engineer at Chrysler, has found a way of capturing the hot exhaust gases and piping them back to the turbine to heat the incoming air. This serves two purposes. It saves fuel and cools the exhaust gases.

Let's take a look at the principles, advantages, and problems of the gas turbine. Up to a point the gas turbine in the automobile is like a jet aircraft engine. In both types, the rotary compressor forces air into the combustion chamber, where it is mixed with kerosene and ignited. The gas then expands, and on its way out of the turbine, gives up part of its energy to the turbine wheel. Now the resemblance ends. In the jet plane, the gases continue outward, and push the plane forward. This would be an impossibility in an automobile, since the hot gases would roast anything behind the car. A second turbine wheel is therefore placed some distance behind the first, permitting the gases to give up the rest of their energy to the second wheel which is connected to an automatic transmission.

Several companies have been working on building gas turbines but Boeing is one of the foremost. They have built several for the Armed Forces. The first in a Navy personnel boat. Others have been developed for use in helicopters, liason airplanes, engineers' pipe lines, pump sets, generator sets, portable air compressors, Army ordnance two and one-half ton trucks, switching locomotives, and Kentworth motor trucks and trailers. All these jobs were done with the same basic turbine.

The advantages of turbines are many. It does not have reciprocating parts and is much smoother and less noisy than a piston-type engine. Having one-fifth as many parts as a piston-engine it therefore uses only one-fifth as much oil. There is no need for a cooling system and the cost of a bulky radiator is eliminated. Its light weight, small size, ideal torque characteristics, flexibility of control and ability to operate on almost any type of fuel, make it ideal for use in transportation. No ignition system is needed except one spark plug, used in starting the engine.

Commercial demand for the gas turbine, has not developed because of the high manufacturing cost, high fuel consumption, and uncertain reliability and

The Chrysler Corporation's new gas turbine engine, mounted in a late model Plymouth. This engine saves fuel, cools exhaust, and attains a higher efficiency than the present day gasoline engines.

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Hughes Field Engineer H. Heaton Barker (right) discusses operation of fire control system with Royal Canadian Air Force technicians. Avro Canada CF-100 shown at right.

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life expectancy. The chief concern for the last few years has been the mechanical failures of turbine blades, turbine nozzles, compressor wheels, burner liners, gas seals, spark plugs, and shaft-bearings. But these troubles have been overcome by:

1. Developing safety factors against the wheel burst.

2. Eliminating wheel rubs from blade stretch, shrouding ring distortion and end movement of hot parts.

3. Eliminating blade base and blade airfoil failure from vibration fatigue, thermal shock cracks, and stress rupture.

4. Controlling starting and acceleration overheating.

5. Controlling unequal distribution of temperature in hot gas stream in order to avoid heat streaks.

6. Preventing blade damage from foreign objects in the gas stream.

7. Developing manufacturing and inspection techniques to assure consistency of quality in blades, wheel disks, and their assemblies.

In discussing the gas turbine, we come to the most difficult part to manufacture —the turbine wheel. Because of the high temperature and rotative stress encountered by this part, it is subject to tremendous strain and requires the utmost precision.

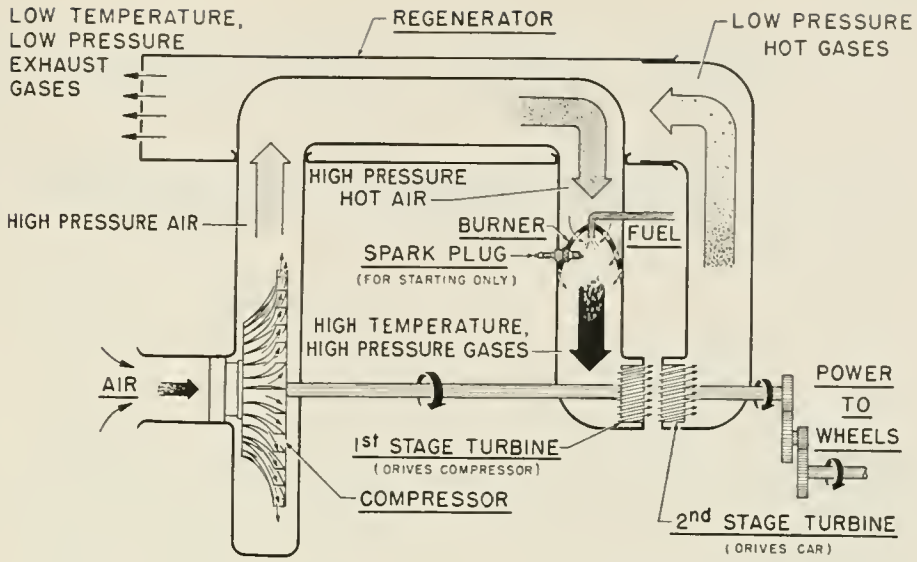
There are two types of turbine wheels, welded and machined. In the first, investment cast blades are welded to a disk type wheel. In the other, the shape of a fir-tree is machined into the circumference of the turbine wheel casting, and the blade is put into the segment cut out. This type of turbine wheel is used on aircraft engines because individual blades can be replaced. With small turbines this type is not very practical since the segment of rim circumference allowed for the blade tang is reduced considerably. It is possible to make wheels by welding cast blades to a forged disk, but X-ray inspection is difficult and rejects are apt to be high for a small defect in one blade rejects the whole wheel. A new type is the bi-metal cast wheel, there the hub is poured as a casting around individual pre-cast blades. This type has a great potential promise due to the low cost of production and that individual blades can be X-rayed and measured before casting.

All this work to make the turbine wheel as reliable as the current piston engines has made it impossible to reduce the manufacturing cost of the gas turbine. As a result of the pressure for reliability, there has resulted highly complex and exacting production requirements for the turbine wheels and their

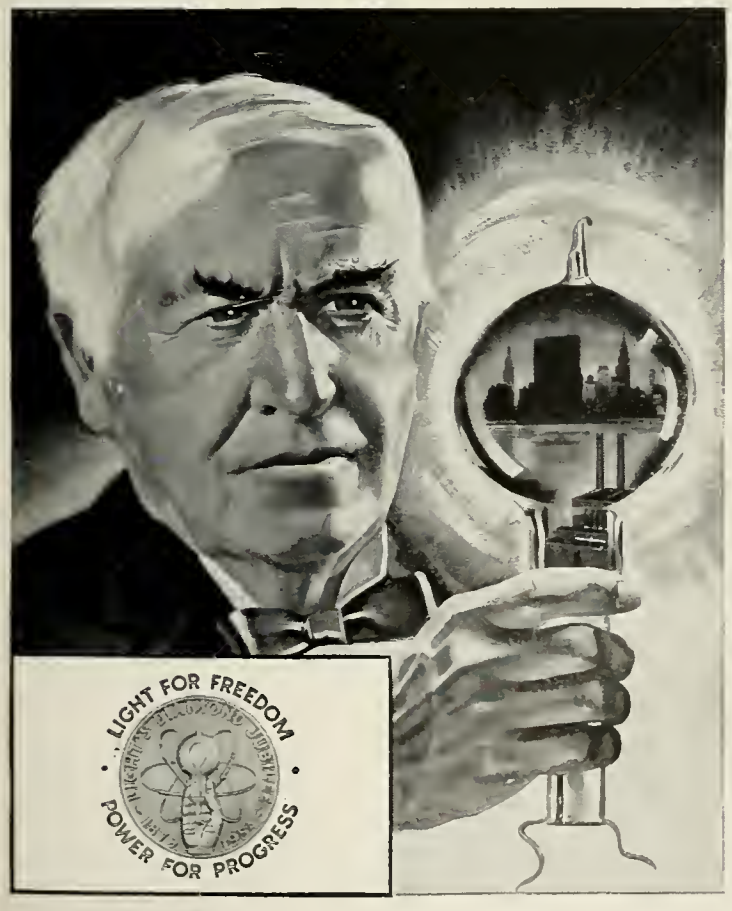
nozzle assemblies, making their cost quite high. In testing these wheels, X-ray and Zygle inspections are used, and with the aid of these inspection methods, chronic types of weld defects can be controlled to a low occurence level. Many people believe that the material of which the turbine consists, is what brings the cost up. Actually, in a $1,000 turbine wheel only $40 is the cost of the actual material. $960 is the most of manufacturing.

One type turbine wheel, starting with the cast blade and ending with the balanced rotor assemble, required a total of 144 steps and 84 separate operations, and no less than 22 inspections of various types.

Study showed that handling time took 84% of actual flow time, as compared to 3½% machining time. This shows that the two major steps necessary to lower the cost of the turbine are reduction of number of operations, and reduction of chances of rejection. Operational welding would reduce the time considerably, and alqso provide better consistency. Elimination of base grinding to obtain a close fit would also cut off a few operations. By using various techniques, the total number of operations can be reduced by almost one-third and shop hours can almost be cut in half. This means a one-fourth reduction in the cost of producing gas turbines, and with mass production the cost would go down still further. With these facts in mind, engineers believe that a practical gas turbine is on the way, and that some day everyone will be driving a turbine powered automobile.



SCHEMATIC DIAGRAM OF
CHRYSLER CORPORATION GAS TURBINE



When Thomas A. Edison first put B&W Boilers to work in the Pearl Street Station, he launched a new industry of electric power which made possible an era of tremendous growth. Electricity—cheap, available, abundant—is the bedrock of America's strength. And certainly, this great pioneer envisioned all the wonders still to come, in the soft glow of his first practical lamp.

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The Use of Slots and the Boundary Layer Fence

by Harvey Roth, Aero E. '55

ABSTRACT

The main concern of this report is to examine what is being done today in the field of boundary layer control. This examination is accomplished by studying the two principle methods employed in this field, slots and the boundary layer fence.

For the analysis of slots, the slot mechanism, pumping equipment, disposal system, and porous cover (when employed) are first discussed. Each different variety of slot mechanism is then analyzed from test data obtained through its use. The test equipment and procedure is also presented in each case.

The only auxiliary equipment employed with the boundary layer fence is spoilers. The use of the fence, with and without spoilers, is discussed. The method of analysis is exactly the same as is used for slots. In both cases, an abundance of visual aids, charts and diagrams, are employed in order to provide greater ease of analysis.

The results of the various tests conducted with either slots or the boundary layer fence are then weighed against each other while keeping in mind the shortcomings involved and the ultimate gains obtainable for each system used. Upon the basis of all these factors, conclusions are drawn as to the probable future of slots and fences and upon the future of boundary layer control in general.

INTRODUCTION

The idea of "controlling" the boundary layer, as well as the foundation of boundary layer theory, was introduced by Prandtl in 1904 when he spoke "Upon Fluid Motion with Very Small Friction."[5]

Early progress in the field of boundary layer control was slow. This was due to the lack of suitable equipment, the difficulty encountered in the design of a duct construction capable of meeting weight and structural requirements and the lack of a sound theoretical background, the early work being of a very empirical nature. Nevertheless, by the outbreak of World War II, several experiments had been conducted in "sucking" the boundary layer through slots cut in existing airfoils. By 1944, ways had been found in airfoil design to produce any desired pressure distribution. This development caused a revival of interest in boundary layer control.[3]

At this point it would be well to define boundary layer control. Some authors classify it as anything tending to improve the boundary layer and even include such things as painting. On the other extreme it is defined "as a method of influencing flow with a source and/or sink."[5] For the purpose of this report, boundary layer control will be defined as any method of adding energy to the boundary layer, such as sucking away the low energy air, mixing air at higher energy levels into the boundary layer, etc.

The two main techniques of boundary layer control in use today are suction or blowing and the boundary layer fence.

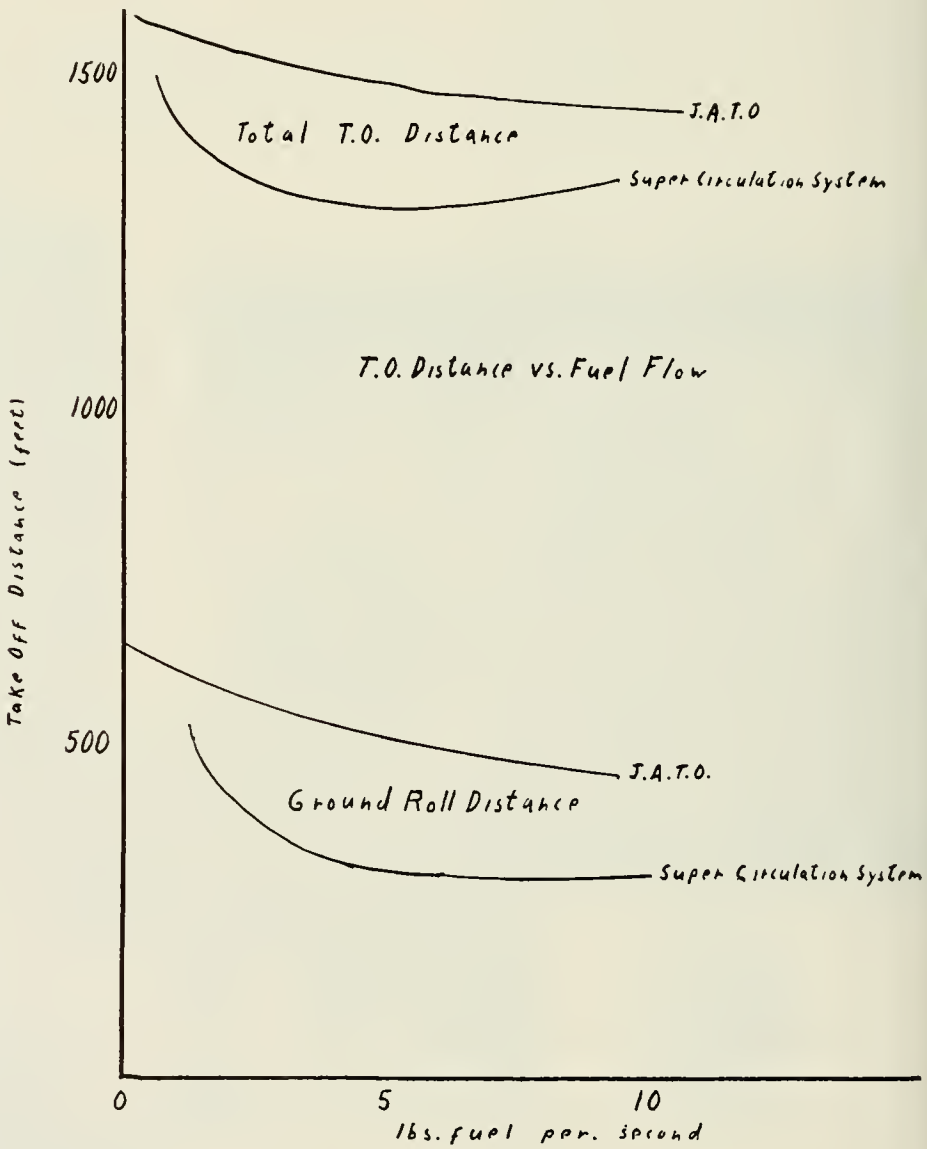

Figure 1[5]

The Use of Slots to Improve Landing and Takeoff Characteristics

Probably the most important advance to date in the field of boundary layer control is the use of slots. Although it is conceivable to use the same slots and the same air pump to increase lift as well as to decrease drag,[3] these two phases have for the main part been attacked separately.

In view of the fact that between 25 and 50% of all fatal civilian aircraft accidents are due to stalling,[2] a figure so high as to cause accident rates to be based on numbers of takeoffs and landings rather than on passenger-miles, it is seen that the more urgent aspect of problem is that of improving low speed characteristics. The wing loadings for military aircraft have more than doubled in the last ten years. Meanwhile the camber, and therefore the maximum lift coefficient, has decreased. From the equation $V_{stall} = \sqrt{K W / S 1 C_{lmax}}$ it is seen that with our present day high wing loadings and thin air foils, the stalling speed will be sufficiently increased to cause trouble. Certainly the use of J.A.T.O. units, catapults and stop wires along the ground cannot be considered as permanent solutions.

Experiments with a Cessna 170

A series of tests have been run with a Cessna 170 equipped with boundary layer control system. The model employing the boundary layer control equipment was designated Cessna 309. The lift coefficient of Model 170 varied between 3.5 and 4.0.

In the inboard section of the wing on Model 309, air is sucked in through a slot. This disposes of the low energy air in the boundary layer and thus retards turbulent separation. This retarding of separation caused an increase in lift coefficient of as much as 1.9[6]. The sucked in air is then sent through a blower and blown out through a slot on the outboard section of the wing. This blowing out of the air over the upper surface of the flap re-energizes the boundary layer and super-imposes additional circulation strength on the field across the airfoil. It is due to this increase in circulation strength that this type of action is often referred to as super-circulation.[5]

The supercirculation adds an increment of lift comparable to that added by the sucking process and also increases the aileron effectiveness due to the rise in momentum.[6]

This increase in lift is felt by a decrease in stalling speed. In the case of the Cessna this amounted to a decrease in stalling speed of 15 m.p.h. The original stalling speed was approximately 50 m.p.h.[5] Landing distance was cut in half and a 40% saving in take-off ground run was also realized.

As a further demonstration of the improved stalling conditions acquired through the use of the super circulation system, level flight was maintained only a few feet above the ground at a speed 11 m.p.h. less than the normal stalling speed. One unpredicted feature of the super circulation system was the ability of Model 309 to take-off at a lift coefficient of 3.0, as compared to the lift coefficient of between 3.5 and 4.0 for Model 170. An improved angle of climb was also obtained. No reason has yet been found for this occurrence.[6]

This system was tested on an F-86 Sabrejet where it also showed very favorable results. The landing speed of the Sabrepet was reduced from 100 to 60 kuots and take-off distance was less than that needed when J.A.T.O. was employed (see Fig. 1). At a fuel flow of five lbs. per second, the normal ground run distance is 650 feet. With J.A.T.O. it is 570 feet and with the super circulation system it is only 300 feet. This system holds an even greater advantage over J.A.T.O. for naval use than for ground use due to the lack of a 50 foot obstacle (see Fig. 1).[5]

Boundary Layer Studies on a Sailplane

Considerable study has been done on the effects of boundary layer control using a sailplane as the test model. The sailplane offers many advantages as a research tool due to the lack of minimumization of noise which tends to cause an early transition. Another troublesome boundary layer hazard which is not present in this case is engine vibration. By having a low original level of turbulence, a much greater turbulence range may be explored. Even more important than this is the ability to add each unfavorable factor separately and thereby observe its relative effect.[1]

One such test was run to determine the relative merit of trailing edge suction which was proposed by Regenscheit near the beginning of World War II. Regenscheit's performance figures looked impressive until they were put to the test by Waltz, who claimed that the decreased friction loss amounted to less than 10% or an amount less than or only slightly more than the power needed to achieve suction. Waltz, furthermore, suggested placing the suction at a point 10% aft of the leading edge.[1]

Thus, arose the question, was Regenscheit's theory wrong or had Waltz merely used a poorly designed slot? The plane used to find an answer to this question was a TG-3A war surplus sailplane in which the rear cockpit was used as the observer post. On the inboard section of the wing, the upper cover was cut away just aft of the leading edge and was replaced by a canvas cover. False ribs were used to make the transition more gradual and the leading edge was made wave free within $\pm$ 0.002 inches.[1]

A traversing wake survey pitot was placed on the trailing edge of the wing and the observer was equipped with a stethescope attached to a probe with which he was able to determine any movement in and the location of the point of transition. In the turbulent section of the wing, a burbling or roaring sound is heard; in the laminar region a gentle hissing is heard. The point of transition is located where occasional bursts of turbulence are heard. In order to test Regenscheit's method, the slot was placed between 96 per cent and 98 per cent chord from the leading edge.[1]

The results were somewhat surprising and quite discouraging. The transition not only failed to be retarded but was even moved forward. This showed that the effects of trailing edge suction do not extend far enough forward to effect the laminar boundary layer. Therefore, any decrease in drag experienced must have been due to a decrease in pressure drag. The main effect of the trailing edge slot is to swallow the low momentum wake thereby decreasing the profile drag.[1]

Waltz's ten per cent slot showed a considerably greater increase in lift. This increase must be weighed against the higher power requirements at this position since much greater suction is needed to suck air in against the high negative pressure on the wing at this forward position.[1]

In T.M. No. 1181—Investigation on Reduction of Friction on Wings, in Particular by Means of Boundary Layer suction, published in 1947, Pfenninger claims that no amount of suction applied downstream will restore a laminar boundary layer once turbulence has set in. Whether this is so or not, it is well known that the entire boundary layer would have to be removed. This removal, if it could be effected, would require considerable suction, far in excess of the amounts normally employed for purposes of boundary layer control.[1]

Dr. A. A. Griffith, on the basis of the fact that if the pressure is made to decrease in the direction of flow, boundary layer separation will be retarded but that it is impossible to maintain this drop over the entire airfoil, suggested that the pressure decrease be allowed to continue to some point far back along the airfoil and at this point cause a sudden discontinuous rise followed by a gradual fall off of pressure. The slot may either suck away or re-energize the boundary layer at this position. Results obtained on an airfoil using Griffith's suggestions were very unsatisfactory. The results of a nose slot appear some-

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what more impressive but even these are not really satisfactory.[3]

The Porous Area Method

The solution for slot design then seems to lie elsewhere, possibly in the use of a porous area and distributed suction. An air inlet placed at the leading edge of the wing carries the air from the pores of the skin to a blower in the cabin below. A porous leading edge is placed over this inlet. The porous leading edge consists of a monel metal filter cloth which has been rolled and hammered to reduce porosity. This is backed by a layer of bronze window screen and a thin sheet of perforated brass to increase the stiffness. The holes in this porous material are so small that light can hardly penetrate them.[4]

The Flight Research Division of Langley Laboratory has taken a conventional high wing personnel plane and substituted a porous metal skin over the leading edge of each wing. Ducts behind the skin are connected to an exhaust system which sucks air in through the skin and either blows it out over the aileron to increase control effectiveness or dumps it out of the fuselage, the former of course being the more satisfactory as was shown in the discussion of the super circulation system. This system smoothed the flow over the skin, caused an increase in lift and delayed the stall.[4]

Some difficulties Encountered in the Use of Boundary Layer Control

Thus, apparently, lies the answer to the problem, but unfortunately many difficulties are encountered in the application of any of the systems discussed so far. In fact, it may well be said that there are many "bugs" in the systems.

One obvious difficulty encountered is the space, weight and power requirements for the pump or blower. A wide variety of pumping equipment has been used.[5]

The first satisfactory application of suction was by the use of the Ardo System which was first used on the piston propelled Ardo-232. Decomposition of hydrogen peroxide provided high pressure steam which was used to run a jet pump.[5] A decrease in duct size is realized by this method when used for supercirculation since the same volume of air is utilized for both suction and blowing.[3]

A similar system was built by Razak which employed a unit supplying hot high pressure steam instead of the hydrogen peroxide jet pump. The efficiency of this unit was considerably lower than the Arado System. It was also considerably heavier. Its advantage was its ability to be used for pumping over a considerably longer period of time.[5]

Two rather ingenious methods of suction were suggested in the use of trailing edge suction. The first of these was to have an opening at the wing tip where, due to the tip vortex, a greater velocity and lower pressure exist. By utilizing the large pressure difference between the wing tips and trailing edge, the suction could be accomplished. The other method to be used with trailing edge suction was to cut a notch in the low pressure section of the leading edge through which air sucked from the trailing edge by pressure difference would also produce a blowing effect at the notch.[3] Although these methods seem quite ingenious, the results of trailing edge suction, as was discussed earlier, proved unsatisfactory.

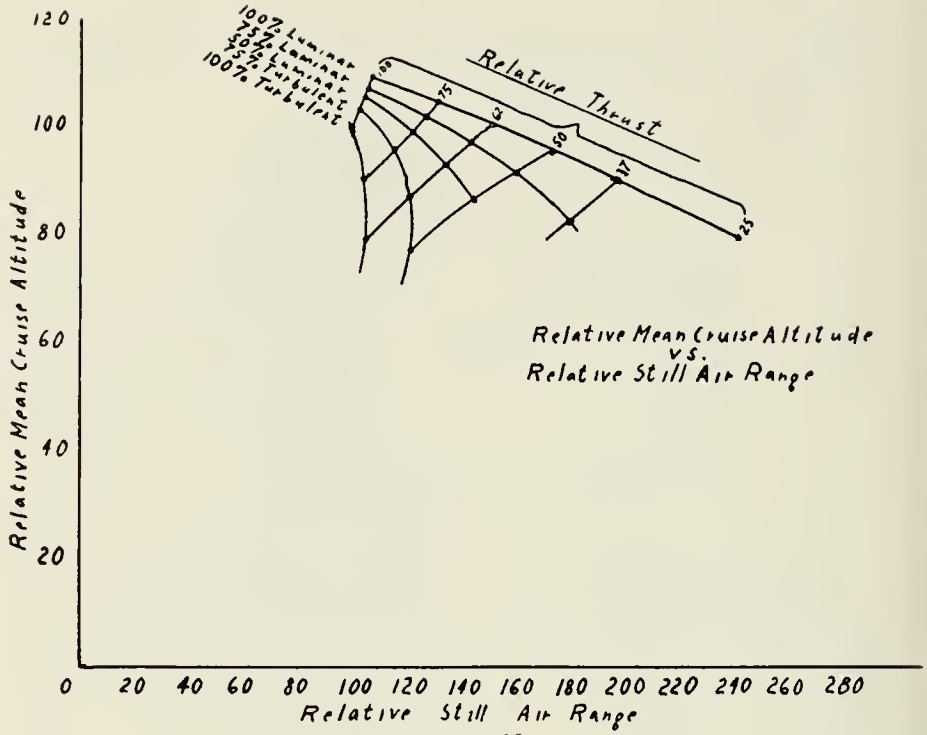

Figure 2[7]

A suggested method, for use in high speed aircraft, is to bleed compressed air from the turbine. This air would be used to drive high speed axial-flow fans to produce the pumping of air over the wings.[4]

A very critical feature in the use of slots is the slot design and location. A poorly or inefficiently designed or poorly located slot will tend to aggravate rather than alleviate the problem. This difficulty is not encountered in the use of a porous surface but the problem of clogging due to insects, dust, rain, etc., is much more critical in this case.[4]

Another defect encountered in the use of a porous surface is the tendency of the surface to produce a destablizing effect on the boundary layer when power is off. This is due to the increased surface roughness produced by the holes. Therefore if something should go wrong with the pumping equipment or should clogging occur, dangerous stalling conditions would be produced.[3]

Probably the most critical problem encountered in the application of boundary layer control is obtaining the proper amount of suction. Rapid forward movement of transition occurs at a suction pressure below some critical value. This critical value was found to be $p/q=1.28$ in the sailplane experiment.[1] This advancing of transition is due to the destabilizing of the boundary layer by local regions of outflow. Over sucking also tends to bring about an early transition due to roughness effects.[7]

Finally, the relative merits of suction and blowing should be considered. It is cheaper to use a blower but the quantity requirements are greater than those for suction. The higher quantity requirements would necessitate the use of thicker wings due to capacity limitations as well as the structural difficulties encountered.[3] Of course, the supercirculation system which utilizes both of these methods may possibly prove the best arrangement. The suction could be accomplished either by a slot or by a porous area while utilizing this system.[5]

Some answers have been given to the problem of clogging. One of these is to place the slot behind the furthest point where insects collect but, due to quantity requirements, as little behind this point as possible.[3] A second and more satisfactory answer is to cover the front of the wing with an expendable cover to be ejected at an insect free altitude.[3] Of course, with this method, either cleaning or replacing the porous cover would be necessary due to the dust collecting in the pores during landing.

Boundary Layer Control for Decreasing Drag

Drag decrease, although a less urgent problem than lift increase, promises to be the more noteworthy contribution due to boundary layer control. Not as much experimental literature has been published on the reduction of drag through boundary layer control although much of the theoretical development has been published.[7]

From this literature, it is evident that the ideal situation would be to maintain continuous distributed suction. This form of suction is, nevertheless, impossible, or at least, extremely difficult to maintain.[7]

Due to the complexity of the topic, the theory of the effects of surface roughness and waviness will not be developed. It is sufficient to say, for the purpose of this article, that extreme care must be exercised in limiting the amount of waviness and the size of an isolated roughness.[7]

One criterion set down was to limit the height of an isolated roughness to no greater than one half the displacement thickness and, in any case, to keep it less than the height of the boundary layer.[7] The waviness too must not become excessive. In the sailplane experiment, it was required to keep the leading edge wave free with ± 0.002 inches.[1] It is this high standard of required surface finish which rejects continuous distributed suction.[7]

Individual sinks, on the other hand, do not offer the advantages of the distributed suction. The optium condition probably lies between these two solutions, or in the use of many closely spaced spanwise sinks.[7]

At 0 incidence and a wind speed of 180 feet per second, transition on the upper surface occurred at 28% chord with a drag coefficient of 0.00322 without suction. With suction applied transition on the upper surface occurred at 93% chord with a wake drag of 0.00078 and a pump drag of 0.00037 or a total effective drag of 0.00115, a reduction of 64.3% as based on the original drag.[7]

Fig. 2 shows the variation of relative still air range with relative mean cruise altitude for various degrees of laminarization. An increase in range along any curve is maintained through the reduction of power plant size. Points representing a given weight and size of power plant are connected on the curves representing each different degree of laminarization. The cruising speed is maintained constant.[7]

It can be seen from the diagram that, by using the same power plant, laminarization does little to increase either the range or mean cruising altitude. This is somewhat deceiving though, since a corresponding increase in altitude for the turbulent plane would involve a sizable increase in power plant and a large decrease in range. Thus it is seen that the maximum gain in range due to laminarization would be obtained with a lighter power plant, with a corresponding decrease in thrust and a lower cruising altitude.[7]

The gains obtainable through laminarization by boundary layer control are, to say the least, impressive. The completely laminar aircraft has two and one half times the range of the turbulent one, its mean cruising altitude being about 20% less.[7]

Of course, a completely laminar aircraft would be somewhat impossible to obtain without imposing ridiculously high suction requirements. A more realistic criterion would be a 50 per cent laminar aircraft. Even this degree of laminarization would mean an increase in range of 45% as compared to the turbulent aircraft with a corresponding decrease in thrust of 50% and a decrease in mean cruising altitude of 14%. The "turbulent" aircraft referred to is a four jet transport for which the needed performance data could be obtained.[7]

If the range of the turbulent aircraft is satisfactory a decrease in fuel consumption could be realized instead. This decrease could in the case of a jet transport be converted into extra passenger and baggage weight.[7]

Due to the reduction in size of the power plant, an unorthodox arrangement could be utilized such as placing the power plant at the tail end of the fuselage. This would reduce the drag of the power plant to a minimum and, in the case of passenger aircraft, would afford the additional advantage of placing the passengers in front of the noise cone.[7]

The fuel saving realized due to laminarization would mean a sizeable increase in revenue for passenger aircraft. It has been estimated, for the British Comet, that a reduction in fuel weight, for the trans-Atlantic crossing of five per cent, converted into additional passengers, would cause an annual revenue increase per aircraft of $560,000. For fighter aircraft, the decreased drag could be utilized for increased cruising speed and the greater maneuverability which accompany a lighter air craft.

The Boundary Layer Fence

As was mentioned earlier, it is possible to use the same system (slot and pump) to both increase the lift and decrease the drag. It, nevertheless, would be difficult to get a pumping system capable of performing both of these functions. It may be more advantageous to use slots and the systems already discussed to decrease drag and utilize some other method to increase lift. One such possible method, showing much promise, is the boundary layer fence.

Work on the boundary layer fence began in 1938 in Germany. The Mes-

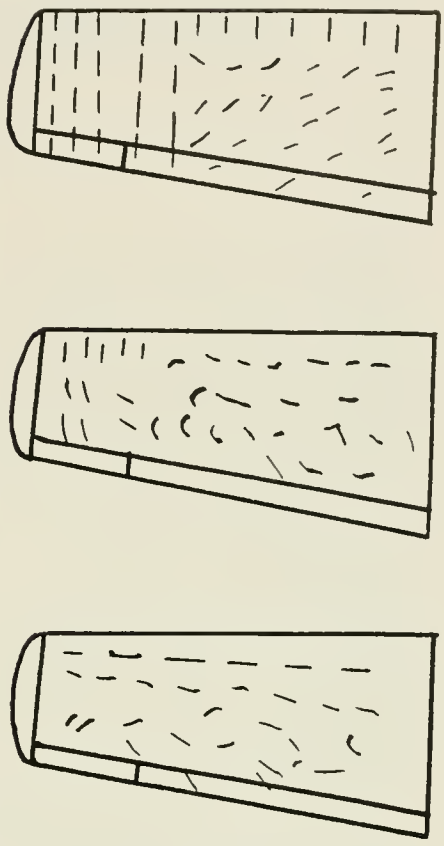

Figure 3[2]

The lines shown are strings taped to the airfoil which show the direction of the air flow.

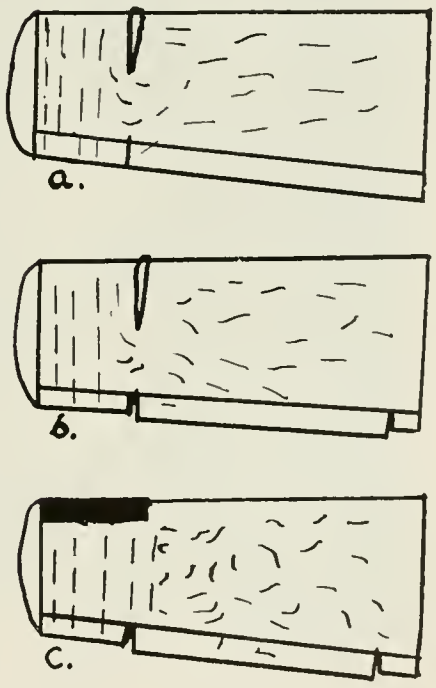

Figure 4[2]

serschmitt ME 109 had at the time been using slots but still had very poor landing characteristics and many pilots were being killed due to sudden rolls on landings.[2]

Pieces of thread were taped to the wings of a Messerschmitt and a camera was used to take photographs of the flow every 0.5 seconds. The results, shown in Fig. 3, indicate a decided cross flow which occured only on one side. The question was whether the cross flow was a secondary effect or the actual cause of the sideway break away of flow.[2]

It was assumed that the cross flow was the cause. Thus the problem was to stop the cross flow. The solution was the boundary layer fence which is nothing but a piece of metal ten centimeters high, placed perpendicular to the wing surface. Fig. 4 shows the flow pattern over the same airfoil as was used to obtain the flow pattern in Fig. 3, in this case, using a boundary layer fence. From Fig. 4, it is seen that the fence stopped the cross flow, retarding the break away of flow.[2]

Flight tests, using the fence, showed a decided reduction in roll near the stall at the cost of a negligible reduction in cruising speed. The cross flow problem is greater for a swept wing and the use of a boundary layer fence is an even greater contribution to swept wing aircraft. The structural simplicity of the boundary layer fence makes possible its addition to planes not designed to use it.[2]

Cross flow is caused by the sucking up of the inert surface air by the low pressure air above it. This creates eddies and piling up of air which is carried out along the span causing cross flow. Cross flow appears to be most critical for the very airfoils which provide the best performance. The fence stopped the flow of the inert boundary layer air outward causing it instead to be sucked upward into the higher energy air above and thereby re-energize the boundary layer.[2]

The boundary layer fence, shown in Fig. 4, placed at mid span, was not the complete solution though, since the flow was still disturbed inboard of the fence and the rolling problem, although somewhat alleviated, was not really solved. Moving the fence inboard only caused a mid wing break away of the flow without cross flow.[2]

Thus, the problem was to get all of the disturbance to occur over a very small inboard section. This was accomplished by using spoilers at the wing root to cause the break away to occur at the root section coupled with a boundary layer fence placed next to the spoilers to stop the disturbance from spreading outward. This combination almost completely eliminated cross flow, limiting it to an almost negligibly small section at the root.

Tests were run on the ME 109 to determine the variation of angle of attack, lift coefficient, and bank with time, using the fence and spoilers as compared to the variation on the same airfoil without fence and spoilers. The results were that the reverse roll characteristics formerly possessed by the ME 109 were almost completely eliminated with no sacrifice in lift.[2]

Some of the planes using the boundary layer fence today are (1) the twin engined De Haviland, D.H. 110 jet fighter, (2) the De Haviland, D.H. 106 "Comet," (3) the S.N.C.A. du Sud.-Est. "Mistral" jet fighter, (4) the Mi G-15 (four fences) jet fighter and (5) the Trojan A-2 sports two seater. The most novel use of boundary layer fences is that employed by the Trojan A-2. In this plane, the wing ribs are fitted outside the stressed skin. The ribs therefore act as boundary layer fences.[2]

Conclusions

This completes the boundary layer picture. From the point of view of stabilizing the laminar boundary layer, the theory looks promising but all that exists is the theory. As far as improving landing and take-off characteristics, much has been done in testing new techniques but nothing really satisfactory has been found.

The critical design and location of slots seems to warrant their abandonment in favor of distributed suction. Distributed suction, on the other hand, shows many pitfalls and much work is still needed there. The use of "gadgets" such as boundary layer fences and spoilers shows some promise but the fact that "gadgets" have to be resorted to at all only further proves the inadequacy of the work done so far. Certainly, the gains offered by boundary layer control warrant the abandonment of our former and present day indifference. A concerted effort in boundary layer research when initiated, promises great dividends for the labor invested.

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Illini Rocket Inquiry

by Jim Piechocki, Aero. E. '56

Maybe we're just plain immature, ut whenever the word "rockets" is entioned, we engineering students tend prick up our ears, drop our slide rules nd homework, and pay strict attention the discussion at hand. In no time all we are an integral part of the ull-session, tactfully displaying our dexrity at cracker-barrel philosophy. So

JIM PIECHOCKI

Jim, a junior in his second semester on this compus, has previously written articles for the TECHNOGRAPH while at Navy Pier. He is now busy in organizing an openhouse program for the Aerodynamics department.

hen someone mentioned the other day iat the Aeronautical Engineering Deartment was inaugurating a rocket reearch program, another round of cofe was ordered, and bull-session experts of the engineering student species) took p the conversation with a new fervor. ut such terms as "interplanetary trav-," "space stations," "galactic drives," c., filtered into the confab and eventuly clouded the sincerity of the original urpose of this elevated discussion, leavig the more down-to-earth type of stuent at a loss for words. Hence, this eporter decided to get the firsthand scoop" from the man behind the proram, Dr. T. P. Torda, of the Aeronauical Engineering Department. Dr. Tora, despite his rigid schedule, very coriially granted an interview to the Techograph. The interview was eagerly anicipated by this writer—and with good eason: Dr. Torda, besides being this bserver's nomination for the title of the busiest man on campus," has the ost vivid sense of humor north of Green Street. So when the time arrived or the inquiry, with pencil in ear, paper n hand, and a few leading questions in ind, we opened the door to the office arked Dr. T. P. Torda and were met ith the remark, "Well, what do you ant to know?" What followed went omething like this:

Just how interested is the Aeronautical Engineering Department in rocket research?

I would say that we are very interested.

Is the department now conducting research in the field of rocketry?

Yes. We have already begun reasearch on two analytical problems in this line, and are looking forward to expansion of the entire program. I have prepared a proposal for a program of experimental sponsored projects dealing with basic combustion and combustion chamber problems.

How extensive is the program now?

As I have said, work has already begun on two analytical problems. One of them concerns the phenonemum of high frequency oscillatory combustion. The other deals with finding an optimum shape of the combustion chamber. Both are Air Force projects. Our facilities at present are somewhat limited. A little rocket shack out at the University airport is the only structure we have that is entirely devoted to rocket study alone. Plans are being drawn up for the construction of a special test stand. The Illinois Rocket Society is also conducting preliminary studies leading to the design of a rocket motor.

How does the Illinois Rocket Society fit into the picture?

The Illinois Rocket Society was formed by students early in 1953 for the purpose of promulgating the study of rocketry at the U. of I. At present it consists of twenty-three members, most of which are engineering students. Liberal arts students have also joined the society. I would like to stress the fact that the IRS is not a "club," but an organization which, through hard work, hopes to eventually become recognized at a professional level and on a national scale. The aims of the society are chief-

Dr. Torda, head of rocket reseorch at Illinois and an authority in the field, feels that rocket design today is more of an art than a science. (Photo by David Komyathy)

ly to study the various fields of rockets and their applications, which includes exterior and interior ballistics (viz., flight and combustion). Their immediate aims are the design of a test stand, instrumentation, and a rocket motor for preliminary tests. We hope to cover every possible field of rocketry. (Note: Dr. Torda is the faculty advisor to the IRS.)

The IRS provides an excellent opportunity for interested students to put their ideas to work on practical problems. If he plans to continue his studies in an associated field, he has a good start.

What are the advantages of having a rocket reseach program on this campus?

There are very few fields of engineering science which require more research than the field of rocketry. Right now there are too many things that we know too little or nothing about. All too often phenomena arise which baffle us. Any rocket research program strives to better this condition. Since industrial research is devoted to applied problems, we will be able to handle problems which industry is not equipped to solve in addition to questions of great interest to the manufacturer.

The opportunities afforded to senior and graduate students are numerous. Look at the various colleges and universities with rocket research facilities. Purdue has for years under Dr. M. Zucrow maintained a rocket research laboratory. The California Institute of Technology maintains a rocket research lab at Pasadena. Princeton and the University of Michigan maintain similar facilities. The stimulating effect of the facilities has been impressive. Student interest in rockets on this campus is high. This is a good sign. The efforts of the Illinois Rocket Society can cultivate these interests and put them to good use.

What about rocket courses in the regular aero curriculum?

Look at the curriculum now. We offer a 300-level course in rocketry for graduate and advanced undergraduate students. Through it, we introduce the student to rocket design and present to him discussions on solid and liquid rockets. Various aspects of aerothermodynamics and chemical kinetics are also discussed. Our plans for the eventual design of a rocket motor are linked to future usage of the unit in this course. Then too, we are planning a graduate course dealing with a more detailed study of actual problems in rocket motor design, such as structural, combustion, and feed system design. Future plans also include a few rocket experiments per semester in the propulsion laboratory.

Getting a little more general, what are some of the big problems hindering rocket development?

A very big problem is the occurence of low and high frequency oscillatory combustion in rocket chambers. This is sometimes called combustion instability. Rapid pressure variations in the chamber are coupled to feed line and structural vibratory modes which are in turn governed by the elasticity of the structure. High frequency oscillatory combustion occurs in large-size rockets of both the liquid and solid propellant type. It is the least understood rocket phenonemon. A tremendous amount of research is required here. Heat transfer through the walls from the combustion chamber is a very complicated phennomenon of great interest. By far the biggest problem in industrial rocketry is the lack of knowledge of the scale effect in building larger motors. The problem of constructing a large rocket engine incorporating the features of a smaller successful unit is an art. We would like to make it a science.

Do you feel that since most of the early rocket research was handled by "enthusiasts", progress has been hampered and industry was inclined to "sneeze" at early efforts?

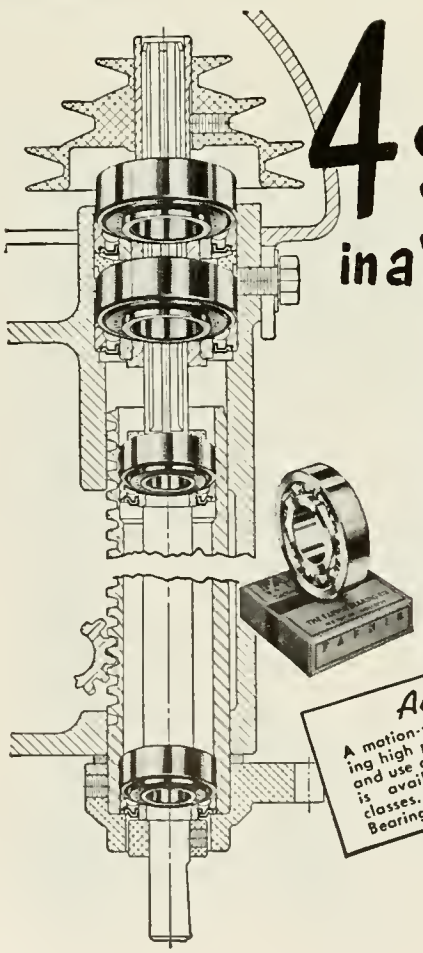
It is true that early efforts were hampered by men who placed emphasis on sensationalism. Opel was an example. But as some of these enthusiasts did valuable work, I don't think industry 'sneezed' very hard at their early efforts. Take von Kármán, one of the most distinguished men in the aeronautical world today. He and his students founded Aerojet and built the first useful solid fuel rocket. And von Kármán is no sneezer. Consider that Aerojet, a subsidiary of General Tire and Rubber Company, has been doing excellent work in the field of rocketry.

How do you feel about the future of rocketry?

Chemical and atomic rockets will be very important for missile work and high-speed planes. But there is still a vast amount of research required, especially in the field of basic combustion. The formation of a rocket research program here at the University is a step in the right direction.

Lady (to porter): Have you a ladies' waiting room?

Porter :No, ma'am. But we have two rooms for ladies who can't wait.



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The spindle of a popular electric power tool for hobbyists literally floats on four Fafnir pre-lubricated Mechani-Seal Type Ball Bearings. Since the power tool operates in both vertical and horizontal positions and under varied conditions . . . as a circular saw, vertical drill, wood lathe, disc sander and horizontal drill press . . . the bearings are extremely important to its accuracy and life. With saw blade at full speed, coins upended on hobby tool table will not fall over . . . a tribute to rigidity gained from use of Fafnir Ball Bearings. Opportunities for product improvement through ball bearing applications are almost limitless. The Fafnir Bearing Company, New Britain, Conn.

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A motion-sound picture depicting high points in manufacture and use of Fafnir Ball Bearings is available to engineering classes. Write to The Fafnir Bearing Company for details.

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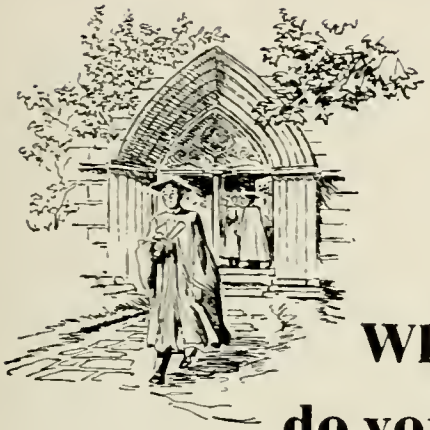

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SQUARE D COMPANY

The Bench M

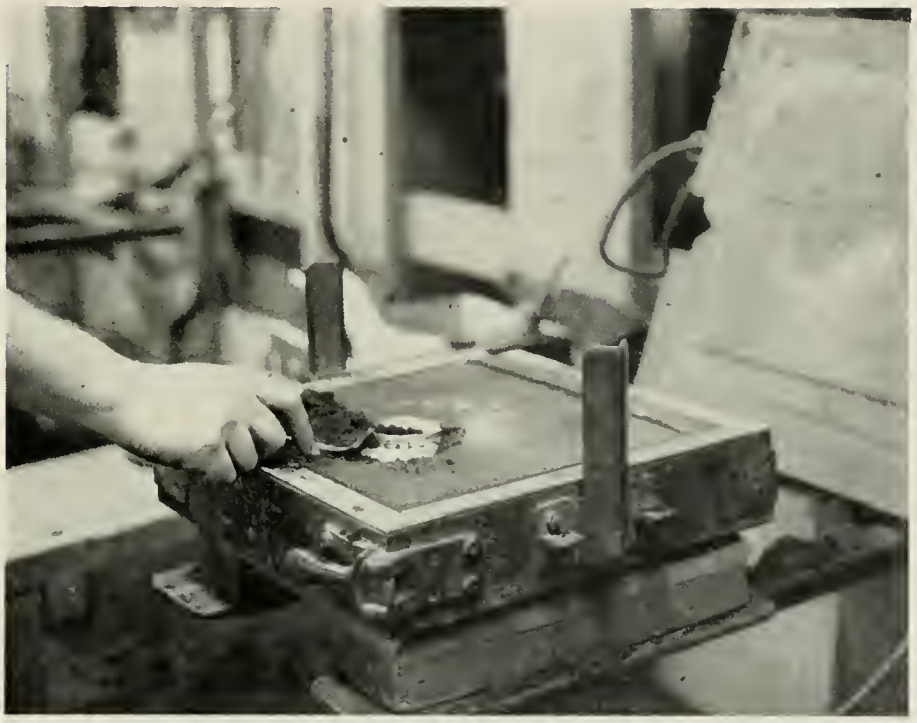
by Robe

The molding process begins with the placement of the drag half of the flask on a molding board in an inverted position with the joint side resting on the board, the pattern can be seen lying on the molding board inside the flask.

The flask is filled to the top with sand and peen rammed firmly around the pattern and along the perimeter of the flask. The function of the peen or wedgeshaped end of a bench rammer is to pack the sand uniformly throughout the depth of the flask.

lding Process

I. E. '57



The drag is turned over, so that the pattern is facing up. Sand is being cleared away from the pattern to make possible the withdrawal of the pattern after the cope has been made. (Photographs by Al Shiner)

The cope half of the flask is placed in position over the drag, and the sprue pin is located near the pattern where the gate will be constructed. A sprue pin is usually a slightly tapered round wood pin, used to form a hole through the cope for the purpose of admitting molten metal to the mold cavity.

NEW METHOD SIMPLIFIES WELDING

A new method of welding that eliminates skills normally required, and claimed to be as easy as turning on a light switch, promises to make it possible for the rapidly growing number of home fixit-yourself and hobby craftsmen to work with metals as readily as with wood. It is expected that the method will also be useful to business and service establishments such as bakeries, hotels, bottling plants, hospitals, body shops, repair shops and other users of metal equipment and machinery that occasionally need a quick, easy method of repair or maintenance fabrication.

The Lincoln Electric Company of Cleveland, Ohio, has developed the new method, called Selfweld, to creat a quick, fool-proof method, usable by everyone, of joining metals for repairing and making such things as metal furniture, household and business equipment, tools, toys and automobiles. Lincoln has also developed a new 100 ampere welding machine for use with Selfweld. The machine, complete with electrodes, Selfweld holder and accessories, costs less than $100.

Selfwelding is said to eliminate the difficulties that would be encountered normally by the amateur in learning the skill of manipulating the welding electrode and controlling the arc. The new method employs a special welding electrode and special electrode holder. To make a weld, the tip of the electrode is simply held against the metals to be joined at the point where the weld begins, a switch on the holder is pressed to fire the electrode, and the electrode, as the tip is held against the metal, automatically makes the weld itself. The electrode and holder normally do the work required of the person welding. Locating the beginning of the weld, starting the arc, feeding the electrode, the electrode angle and the travel speed are controlled automatically by the design of the electrode and holder. A supporting leg on the holder can be used to help locate and steady the electrode on the joint and to control the angle of the electrode. The coating of the electrode touches the work at all times so that the arc length is automatically determined. The melt-off rate automatically controls welding speed. Excellent welds are made on the first try, it is claimed.

This Selfweld, made by the Lincoln Electric Company of Ohio, reduces the skill required in welding to that of a common home craftsman.

PROBLEM:

How Many Cigarettes?

Five men are in poker game: Brown, Perkins, Turner, Jones, and Reilly. Their brands of cigarettes are Luckies, Camels, Kools, Old Golds, and Chesterfields, but not necessarily in that order. At the beginning of the game, the number of cigarettes possessed by each of the players was 20, 15, 8, 6, and 3, but not necessarily in that order.

At a certain time during the game, when no one was smoking, the following conditions exist:

(1) Perkins asked for three cards.

(2) Reilly had smoked half of his original supply, or one less than Turner smoked.

(3) The Chesterfield man originally had as many more, plus half as many more, plus 2½ more cigarettes than he now has.

(4) The man who was drawing to an inside straight had absent-mindedly lit the tipped end of his fifth cigarette, the last one he smoked.

(5) The man who smokes Luckies had smoked at least two more than anyone else, including Perkins.

(6) Brown drew as many aces as he originally had cigarettes.

(7) No one had smoked all his cigarettes.

(8) The Camel man asks Jones to pass Brown's matches.

How many cigarettes did each man have to begin with, and what brand?

(Answer on Page 44)

QUARTZ CRYSTALS

How a 1¼ hour "gem-cutting" operation became an 8-minute mechanized job

PROBLEM: Preparing quartz crystals for use as electronic frequency controls calls for the highest degree of precision. So much so, in fact, that prior to World War II skilled gem-cutters were employed to do the job.

But during the war, there were not enough gem-cutters to keep up with the demand for crystals in radar, military communications and other applications.

Western Electric tackled the job of building into machines the skill and precision that had previously called for the most highly skilled operators.

SOLUTION: Here is how quartz crystals are made now—by semi-skilled labor in a fraction of the time formerly required:

A quartz stone is sliced into wafers on a reciprocating diamond-edged saw, after determination of optical and electrical axes by means of an oil bath and an X-ray machine. Hairline accuracy is assured by an orienting fixture.

The wafers are cut into rectangles on machines equipped with diamond saws. The human element is practically eliminated by means of adjustable stops and other semi-automatic features.

The quartz rectangles are lapped automatically to a thickness tolerance of plus or minus .0001". A timer prevents overlapping. Finally, edges are ground to specific length and width dimensions on machines with fully automatic microfeed systems.

Most of these machines were either completely or largely designed and developed by Western Electric engineers.

RESULTS: With skill built into the machines —with costly hand operations eliminated— this Western Electric mechanization program raised production of quartz crystals from a few thousand a year to nearly a million a month during the war years. This is just one of the many unusual jobs undertaken and solved by Western Electric engineers.

Quartz stones are cut into wafers on this diamond-edged saw, with orientation to optical axis controlled by fixture. This is just one of several types of machines designed and developed by Western Electric engineers to mechanize quartz cutting.

Western Electric

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Manufacturing plants in Chicago, Ill.; Kearny, N. J.; Baltimore, Md.; Indianapolis, Ind.; Allentown and Laureldale, Pa.; Burlington, Greensboro and Winston-Salem, N. C.; Buffalo, N. Y.; Haverhill and Lawrence, Mass.; Lincoln, Neb.; St. Paul and Duluth, Minn. Distributing Centers in 29 cities and Installation headquarters in 15 cities. Company headquarters, 195 Broadway, New York City

Recognized Minimum Standards

A *"Recommended Minimum Standard"* for commercial carbon steel castings, developed by the Steel Founders' Society of America, is ready for distribution to users and producers of steel castings. This is the first "Minimum Standard" in the century long history of the Steel Casting Industry.

This "Standard" is the outgrowth of studies made by the S.F.S.A. Product Development Committee and subsequent recommendations calling for its preparation. Succeeding work and its ultimate drafting became the task and the accomplishment of the Specifications Committee. Thorough discussion in each of the eight society divisions throughout the country focused the practical technology of the entire Society's membership into its final composition.

Acceptance of the "Standard" will be voluntary on the part of both the customer and the steel foundry source of castings. It is not expected, nor is it intended that it displace other specifications now in use. It does, however, establish a firm basis by means of which the purchaser and the supplier of general commercial cast steel components can arrive at a common understanding. It represents a common sense approach to a fuller use of the properties inherent to cast carbon steel. With this "Standard" the Steel Founders' Society of America goes on record as advocating the purchase and sale of carbon steel castings in a preferable physical and metallurgical condition.

The "Standard" emphasizes that its requirements are minimums and that they are not designed to influence in any way the production of castings which are practical improvements on such minimums. It is intended that all clauses apply unless otherwise agreed upon by producer and customer.

Quality control procedures, primarily in regard to physical and chemical properties, will govern production of steel castings under conditions set forth in the "Recommended Minimum Standard." Control of these properties implies a need for similar techniques in the selection of raw materials and the processing steps through the melting and heat treating cycles. Quality control procedures are a growing factor in steel casting production. Selection and control of sand properties, selection and use of scrap, relationship of casting size and shape to metal pouring temperatures, required temperatures and treatment for proper alloying, rate of heat input in both melting and heat treating, process inspection, mold cooling cycles, and variations in dimensional shrinkage are a few of the items in a steel foundry that lend themselves to such techniques.

Heat treatment of steel castings is emphasized. The "Minimum Standard" recommends either full annealing, single normalizing, or tempering (stress relieving) as desirable treatments. Research reports and literature issued by the Steel Founders' Society have identified the improved design properties achieved by heat treatment. A machinability research shows that heat treatment improves the machining characteristics of cast steel, an important factor in the cost of metal components.

Note is also made as to the desirable practice of furnishing a casting drawing along with pattern equipment. Under this condition the foundry assumes the responsibility for checking to insure accurate dimensions in the finished casting. Such action is particularly important when attempting to use equipment originally made for other metals or when wood patterns are stored for periods of time. The growth and contraction of wood with the seasons is sufficient to throw long dimensions out of line or warp a pattern in such a manner as to create an out-of-shape casting. This fault is particularly true of the so called "inexpensive patterns."

Methods for maintaining specified physical and chemical properties are set forth in the body of the "Standard." Variations in the chemical content are subject to constricting totals designed to give proper metallurgical balance. Inspection requirements as to external quality are at the visual level with dimensional limits checked by gauges and fixtures where required.

During the development of the "Recommended Minimum Standard" several foundries adopted the practices advocated as a basis for their own operation. There will be applications and production, however, where the quality level set forth in this Standard is not required. It must be emphasized that the use of this Standard is a matter of voluntary agreement between the foundry supplying the steel casting and the buyer.

The creation of this "Minimum Standard" is a natural and logical outgrowth of activities within the Steel Founders' Society. Today, some thirty research projects sponsored by the society are published and available to its members. Some portions of these are supplied to customer industries as guides in the use of steel castings. Twelve additional projects are under way and others are contemplated. All of these are directed toward the improvement of steel casting production methods and the metallurgical and physical properties of the various carbon and low alloy cast steels.

Technical and operating conferences in each of the eight divisions of the society are continuously developing the use of information coming out of this research program, as well as providing a medium of free exchange for operating and technical ideas among the steel foundries in a given area. The ninth National Technical & Operating Conference was held this fall on November 3, 4, and 5, in Cleveland, Ohio.

Paralleling these activities is an active product development program designed to discover new steel casting applications and improve the design of cast steel components. Among the duties of the Product Development Committee are the promotion of casting quality, design, and new products.

The "Recommended Minimum Standard" becomes one of the first steps in a marketing program now being initiated by the Steel Founders' Society of America. Quality, dependability, and reliability are marketing instruments in themselves. Improved physical and chemical properties constitute another market improving device. The adopted "Standard" promotes these factors.

Copies of the "Recommended Minimum Standard," as well as a booklet entitled "The Machinability of Cast Steels" are available free upon request to the Steel Founders' Society of America, 920 Midland Building, Cleveland 15, Ohio.

Recommended Minimum Standard for Commercial Carbon Steel Castings . . .

adopted by

The castings are now on the way to the grinding room

STEEL FOUNDERS' SOCIETY OF AMERICA

This recommended minimum standard is applicable to steel castings commonly referred to as "commercial carbon steel castings" (readily weldable grade).

This minimum standard shall apply only when no customer specification, calling for another order of quality, is made a part of an order.

It cannot be too strongly emphasized that the requirements of this standard are suggested minimums, and that they are not intended to influence in any way the production of castings which are improvements on these minimums.

It is the intent of this recommended minimum standard that all clauses apply unless otherwise agreed upon by producer and customer.

A—Material and Workmanship

A-1. The castings shall, as determined by visual examination, be free from cracks, shrinkage cavities, hot tears, swells, scabs, blowholes and pinhole porosity, that impair the utility of the castings.

A-2. Castings shall be free from sand and scale on all surfaces to the extent that normal machining operations can be performed without the necessity for further cleaning by the customer.

B—Detail Requirements

B-1. Castings shall have gates and risers removed in such a manner that no riser or gate stub projects beyong the casting design contour in an amount that would exceed the following values:

Riser or Gate Maximum Dimension inches	Maximum Projection inches
Up to 4	1/8
4+ to 8	1/4
8+ to 20	3/8
20+ to 30	1/2
Over 30	3/4

B-2. The removal of gates and risers shall not produce depressions which are more than 1/8" below the casting design surface; except that for castings having risers greater than 20" maximum dimension the depression shall not be more than 1/4" below the casting design surface.

B-3. The responsibility for furnishing castings that can be laid out and machined to the finished dimensions, within the tolerances given and without further straightening by the customer, shall rest with the foundry only if both a pattern and drawings are furnished. If the foundry is furnished a pattern without accompanying drawings, the foundry fulfills its responsibility as to casting dimensions by furnishing castings which are true to the pattern.

B-4. Castings shall be within a weight limit of +5 or —3 per cent.

C—Heat Treatment

C-1. Pyrometric equipment shall be used to enable the heat-treating procedures given in C2 to C4 to be satisfactor-

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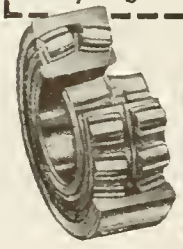

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ily carried out. Pyrometric equipment shall be maintained in accurate condition at all times. Checks for accuracy shall be made at least once each 30 days.

C-2. Castings shall be heat-treated by one of the following three methods at the option of the manufacturer:

(a) Full Annealing

(b) Normalizing

(c) Normalizing and tempering (stress relieving)

C-3. *Heating.* Regardless of the heat treatment employed, the castings shall be uniformly heated to a temperature above the transformation temperature and shall be held at this temperature for a sufficient length of time to refine the grain. The temperature difference between the hottest and coolest part of the charge during the holding period shall not be greater than 75°F. (See Note A)

C-4. *Cooling.* The castings shall be cooled as follows:

(a) Full Annealing. Castings shall be cooled slowly in a closed furnace from the annealing temperature. When the temperature of the furnace has fallen to 1000 degrees the castings may be removed and cooled in air.

(b) Normalizing. The castings shall be removed from the furnace and cooled in air.

(c) Tempering (stress relieving). Castings shall be heated to a temperature below the lower critical and held at this temperature for not less than one hour. After the heating period the castings may be furnace cooled or removed from the furnace and cooled in air.

D—Repair of Defects

D-1. The welding of steel castings, whether for repair of defects or addition of other structures, is permitted at any point in their processing provided the following conditions are complied with:

(a) The defect shall be thoroughly and completely removed.

(b) The area to be welded shall be clean and free from sand and scale or other extraneous material.

(c) The welding shall be performed in accordance with the procedures stipulated in the SFSA Recommended Practice for the Welding of Steel Castings.

NOTE A: For information on the transformation temperature for commercial carbon steel castings see Fig. 283, page 209 in the Steel Castings Handbook, 1950 Edition.

E—Methods of Sampling, Inspection and Tests

E-1. All castings shall be surface inspected for defects and surface appearance after final cleaning for shipment.

E-2. Representative castings from each order or lot shall be inspected for adherence to tolerances.

E-3. It is recommended that for castings in lots of 50 or more and, if practical, castings should be inspected by destructive or non-destructive tests to ascertain whether they are as sound as ASTM Radiographic Standards, E-71, Class 4.

E-4. One tension test shall be made from each heat in each lot. The design of such test coupons shall be the Standard ASTM Test Coupon illustrated in ASTM Tentative Methods and Definitions A370-53T (Mechanical Testing of Steel Products). If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted from the same lot. The term

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says GERALD SMART

Marquette University, BS—1948
and now Supervisor of Plant Engineering,
Allis-Chalmers, Norwood, Ohio, Works

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"My case is a little different, however. I started the course with all my interest centered on tool design and 'in-plant' service. The reason is that I started getting vocational guidance from some very helpful Allis-Chalmers men back in 1940."

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"Then came the war and service in the Navy. After the war I finished school. By the time I started on the course in 1948, I knew what I liked and seemed best fitted to do. As a result, my entire time as a GTC student was spent in the shops.

"The 18 months spent in the foundry, erection floor and machine shop have all proved valuable background for my present job.

"As supervisor of plant engineering at the Norwood Works, I am concerned with such problems as: Plant layout, material handling equipment and methods, new construction, new production methods to be used in building motors, centrifugal pumps, and *Texrope* drives. It's an extremely interesting job.

"From my experience, I'd say, whether you're a freshman or a senior it will pay you to talk to an Allis-Chalmers representative now. You can't start planning your future too soon. And you can't plan starting at a better place, because Allis-Chalmers builds so many different products that you'll find any type of engineering activity you could possibly want right here."

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1. It's well established, having been started in 1904. A large percentage of the management group are graduates of the course.

2. The course offers a maximum of 24 months' training. Length and type of training is individually planned.

3. The graduate engineer may choose the kind of work he wants to do: design, engineering, research, production, sales, erection, service, etc.

4. He may choose the kind of power, processing, specialized equipment or industrial apparatus with which he will work, such as: steam or hydraulic, turbogenerators, circuit breakers, unit substations, transformers, motors, control pumps, kilns, coolers, rod and ball mills, crushers, vibrating screens, rectifiers, induction and dielectric heaters, grain mills, sifters, etc.

5. He will have individual attention and guidance of experienced, helpful superiors in working out his training program.

6. The program has as its objective the right job for the right man. As he gets experience in different training locations he can alter his course of training to match changing interests.

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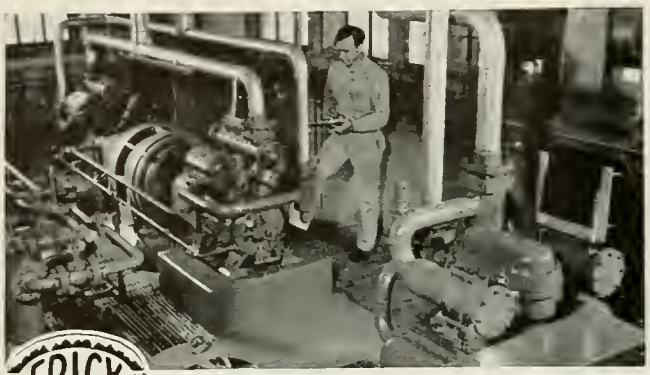

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"lot" shall be considered as all castings in a heat subjected to the same heat-treating procedure. After meeting acceptance tests for ten consecutive heats used for making castings of any one grade, the manufacturer may assemble the castings from succeeding melts in groups of five heats each. The castings in each group shall be accepted on the basis of one test specimen taken from every fifth heat, provided that the chemical anlysis of all the heats in the group falls within the range established by the first ten consecutive acceptable heats and all subsequent heats that are physically tested and found acceptable. If this test fails, the heat may be requalified by using another specimen, and the four other heats in the group shall be tested individually. The same heat-treating procedure used for the first ten consecutive heats shall be used for all subsequent heats. This procedure shall be established for each grade separately.

E-5. In cases where more than one heat is poured into a ladle (teeming of several heats), the heat shall be deemed to be the ladle from which the castings are finally poured.

E-6. The coupon, for mechanical test specimens, shall be poured with metal which has received deoxidation treatment identical to that metal from which the castings are poured.

E-7. One tension-test specimen from each lot (as qualified in paragraph E-4) shall be tested and shall meet the minimum properties noted in Table I.

E-8. When any test specimen shows defective machining or obvious lack of continuity of metal, it may be discarded and replaced by another specimen from the same lot.

E-9. In the event two test specimens from any lot fail to meet the minimum requirement noted in Table I, the castings may be re-heat-treated as often as desired with a coupon from the same heat.

E-10. Chemical analysis of each heat shall be made to determine acceptance as noted in Table I. Drillings for chemical analysis may be taken from broken test specimens, castings poured in the heat or from a separate block representing the melt. (See Note B)

NOTE B: The alloying elements Mo, Cu, Ni and Cr need not be determined by analysis on every heat, but it is recommended that they be determined at intervals.

TABLE I

Chemical and Mechanical Property Requirements

Chemical Composition—Maximum percent								
C*	Mn*	Si†	P	S	Mo**	Cu**	Ni**	Cr**
.33	.70	.80	.06	.06	.20	.50	.50	.25

*For each reduction of .01 percent carbon under the maximum specified, an increase of .04 percent manganese above the maximum specified will be permitted.

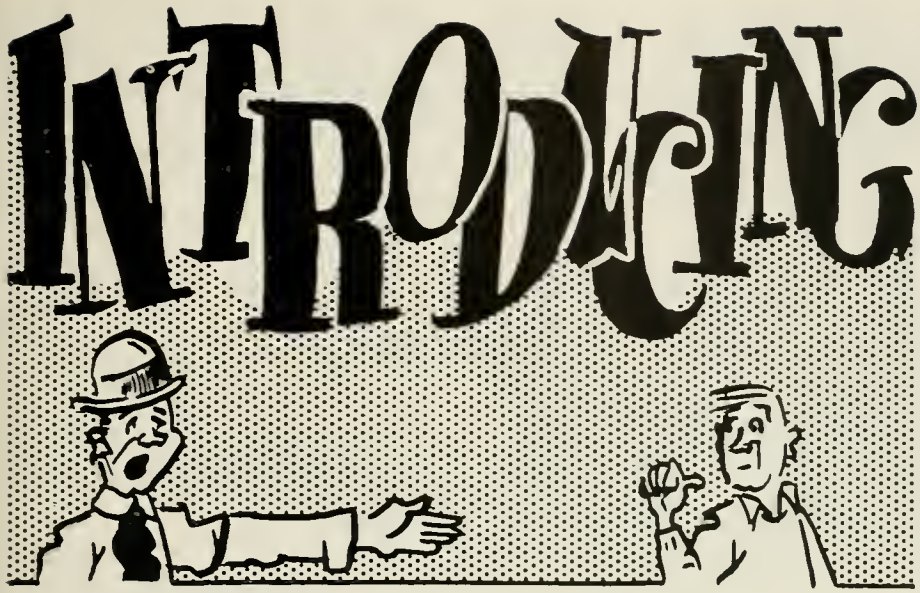
†Minimum silicon permitted is .25 percent.

**Total content of these unspecified elements shall not exceed 1.00 percent.

MECHANICAL PROPERTIES***

Tensile Strength Minimum psi	Minimum psi Yield Point	Elongation in 2 inches % Minimum	Reduction in area % Minimum
60,000	30,000	24	35

***Mechanical properties shall be determined on the standard 0.505 inch diameter tensile test bar, either with or without threaded ends.



by Harvey Endler, Eng. Phy. '56 and Donnie Snedeker, E. E. '58

DR. E. C. JORDAN

Dr. Jordan, the recently appointed head of the Electrical Engineering Department here at the University of Illinois, attributes his career in electrical engineering to a boyhood interest in radio. While working in a drugstore in

DR. JORDAN

Edmonton, Alberta, Canada with aspirations of becoming a pharmacist. Dr. Jordan heard of a job opening at CKUA, the radio station of the University of Alberta, and his deep interest in his hobby led him to forsake pharmacy and take the job as a technician for the studio. He began taking selected courses at the University of Alberta, and soon discovered that he was able to take a full engineering program in addition to working as a control operator for the station.

In 1933 he built for CKUA the first studio control board with automatic gain control, which was, incidentally, the topic of his Master's Thesis. He received his B.Sc. and M.Sc. in 1934 and 1936 respectively, from the University of Alberta. He then taught at Worchester Polytechnic Institute and Ohio State before coming to Illinois in 1945 as an associate professor of electrical engineering. In 1947 he became a professor and in July of this year was appointed head of the department. In addition to heading the department Dr. Jordan teaches the first graduate level course in electromagnetic theory, using his own book, "Electromagnetic Waves and Radiating Systems."

Dr. Jordan has carried on extensive research on antennas, a subject in which he first became interested while teaching at Ohio State. A great deal of this research was carried on during the war under contract of the Office of Scientific Research and Development, and dealt mainly with antennas for high speed aircraft.

Dr. Jordan is married and has three boys, ages six, nine, and ten and a half, whose only interest in electrical engineering thus far has been in turning the TV set on and off. However, to anyone else who is considering entering the profession, Dr. Jordan recommends that they have a liking for mathematics and physics. To those already in engineering he gives the words of advice that "what you get out is directlfy proportional to what you put into your work," and that the best system is "to work like a dog but have fun doing it." He is a firm believer in the importance of extracurricular activities for engineering students.

JIM SMITH

Who says Agricultural Engineers never get off the farm? Here's one who's really been around —

A native of Pennsylvania, Jim graduated from high school in Elmira Heights, New York, where he played football, basketball, and served as president of his class. Cornell University came next for three semesters before he enlisted in the Army. After deciding that a private's life was not for him, Jim took and passed the test for West Point preparatory school. He studied for one year and in July, 1952, entered West Point. Upon completing freshman year, Jim resigned his appointment and came here to the University of Illinois

JIM SMITH

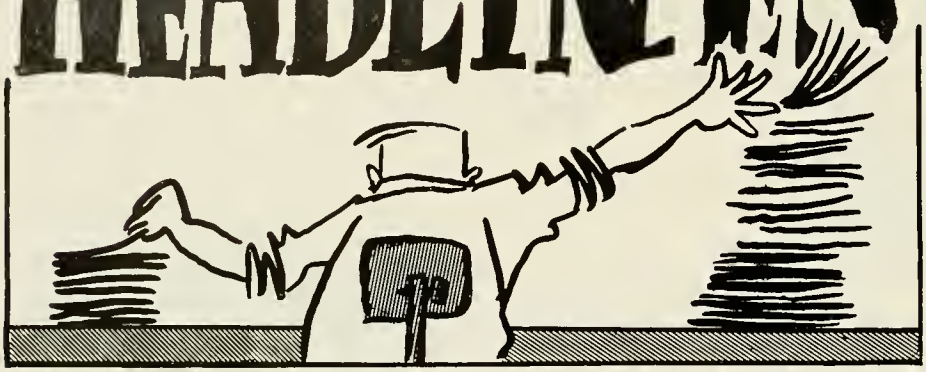
to study Agricultural Engineering.

One of those pretty Illinois girls had her trap laid for him and last August, she became Mrs. Carolyn Smith. Jim seems to like being trapped, though!

Besides serving as Business Manager of the Technograph this year, Jim is a member of the Engineering Council and president of the Illinois Student Branch of the American Society of Agricultural Engineers. All this and studies, too, but he still tries to find a little time for hunting, fishing, and playing golf.

After receiving his sheepskin in 1956, Jim hopes to remain on at the University for graduate work or go into tractor test and design.

SKIMMING INDUSTRIAL HEADLINES



edited by Larry Kiefling, M. E. '56

Super Sabre

The Air Force Tactical Air Command today received its first F-100 Super Sabres and soon will have squadrons capable of fighting at speeds faster than sound.

Ten minutes after accepting delivery of his unit's first F-100 at North American Aviation's Los Angeles plant, Lt. Colonel Maurice G. Long, commander of the 436th Day Fighter Squadron, oashed across George AFB, 75 miles away.

"I barely retracted my landing gear before it was time to let down at George," the dark-haired veteran fighter pilot declared. "This faster than sound flight is really something."

J. S. Smithson, vice president of manufacturing at North American, pointed out that the F-100 has been on or ahead of schedule since delivery of the first supersonic fighter to the Air Research and Development Command last October. The prototype of the Super Sabre was first flown on May 25, 1953. Five months later it roared across a 15 kilometer course near the Salton Sea at an average speed of 755.149 miles an hour to set a new world's speed record.

The Air Force recently announced that a new order of $100 million has been placed for a second source of production of the F-100 at North American's Columbus, Ohio, plant.

The F-100 has been in production at Los Angeles since mid-1953 and will continue to come off assembly lines at the West Coast plant.

The 479th Fighter Wing at George will be the first operational unit to be equipped with the F-100. The new supersonic fighter will replace North American F-86F Sabre Jets which won fame in Korea by shooting down Russian-built MIGS at a rate of 13.8 to 1. The F-100 can be modified as a fighter bomber and the Air Force has announced it is capable of carrying an A-bomb.

An extensive flight testing program on the F-100 has been conducted at Edwards AFB by Air Research and Development Command and company test pilots. The Air Training Command, Air Proving Command and Air Materiel Command also have test flown the new fighter.

The F-100 incorporates a razor thin, 45 degree sweptwing and tail and was especially designed for high speed flight. The new, heat-resisting metal, titanium, is used extensively throughout the plane. It is powered by the powerful Pratt and Whitney J-57 turbojet with afterburner rated in the "10,000 pound thrust" class.

Maintenance crews have reported the F-100 much easier to work on because of quick access to radio, radar, electrical and other accessory equipment.

Ready for delivery to the Air Force are these F-100 Super Sabre Jets at a North American Aviation's plant. The Air Force has just placed a $100 million order for more of these planes.

Heat-Sensing Cell

Little slips of glass coated with lead sulfide that can give 10,000 times as much sensitivity to certain infrared rays as previous laboratory instruments have now been put on sale to science and industry.

Known as Kodak Ektron Detectors, the new photoconductive cells were first unveiled at the convention of the American Society for Testing Materials. The extreme infrared sensitivity of the cells, coupled with their simpilicity and adaptability to manufacture in any size or shape, opens wide new possibilities to engineers in developing new devices based on the ability to detect warm ob-

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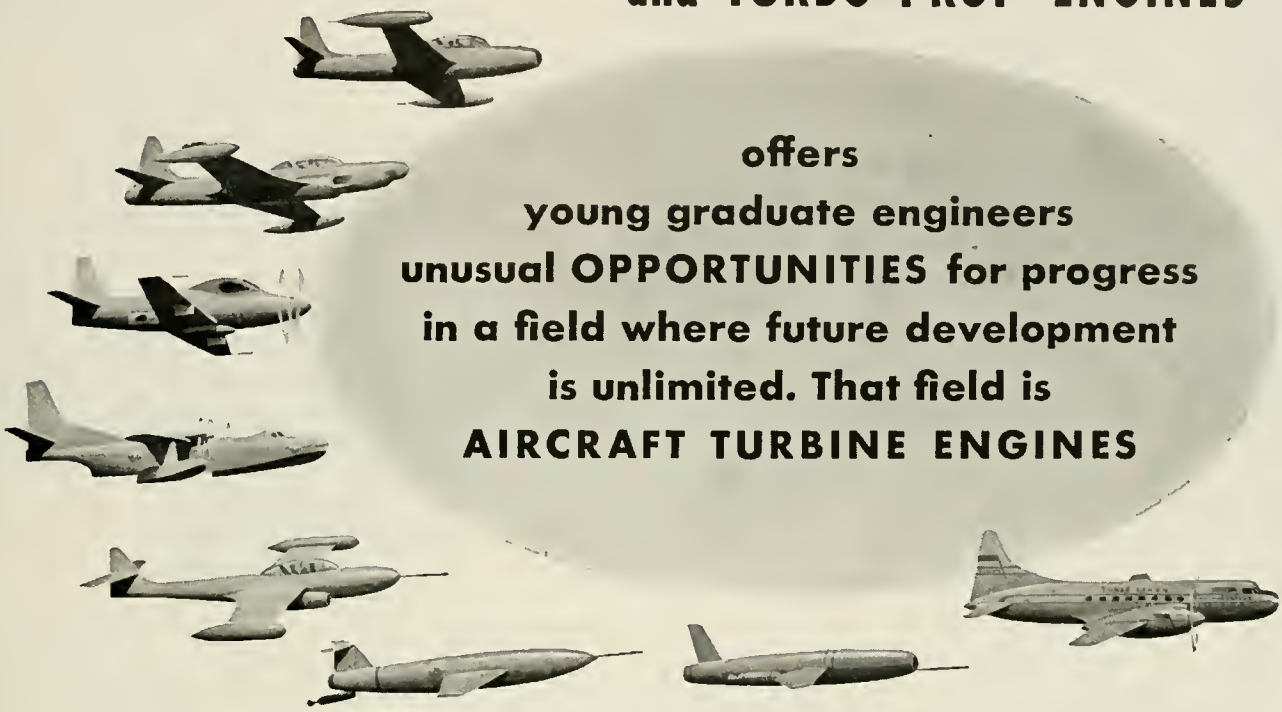

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Delbert N. De Young received a B.S. in Chem. Eng. from the University of Wisconsin last June. Now he is working for an M.S. degree. By asking questions, he's learned that many excellent industrial opportunities are passed over because they're not understood by the average undergraduate.

Del De Young wants to know:

What sort of work is involved in technical sales at Du Pont?

Clarence D. Bell, B.S., Chem. Eng., Univ. of Pitts. (1937), joined Du Pont as a chemical engineer immediately after graduation. He began in the research group of the Ammonia Department, progressed steadily through assignments on nylon and a number of other products. Today he is an Assistant Director of Sales in the Polychemicals Department.

Clarence "Ding" Bell answers:

Well, if I said "All sorts," it might sound a bit vague to you, Del, but it would be very close to the truth. That's because technical sales work at Du Pont—bearing in mind the great diversity of products we have—is broader in scope than a lot of other technical assignments, and requires additional talents.

Let's suppose that one of Du Pont's customers is having technical difficulties—needs help in adapting "Teflon" to a specific gasketing application, for example. When our sales representative calls, he naturally must carry with him the engineering knowledge that's the basis for sound technical advice—data on flexural fatigue, chemical passivity, and deformation under load. The customer is receptive. He wants to make a better product, increase his sales, reduce costs—or do all three. Naturally, he's looking for reliable technical advice and intelligent actions that apply to his specific conditions. With the cooperation of the customer and help from our own research people, when necessary, the problem will sooner or later be "licked."

We have found, though, that if a technical service man is going to be *truly* effective in such a situation, he must possess certain *human* qualities in addition to his technical ability. That is, he must really *like* people and be sincerely interested in helping them solve their problems. He must—in every sense of the word—be an "ambassador" who can handle human relationships smoothly and effectively.

Take the depth suggested by this simple example, Del, and multiply it by a breadth representing all the challenging problems you'll run into with Du Pont's diversity of products. If your slide rule isn't too far out of alignment, the resulting area should give you some idea of what I meant by "all sorts" of work.

Let me emphasize one more point. The importance of effective sales work is fully understood and appreciated at Du Pont! In the past, sales work has been one of the active roads to top management jobs. There is every reason to believe that this will continue in the future.

DU PONT
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BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

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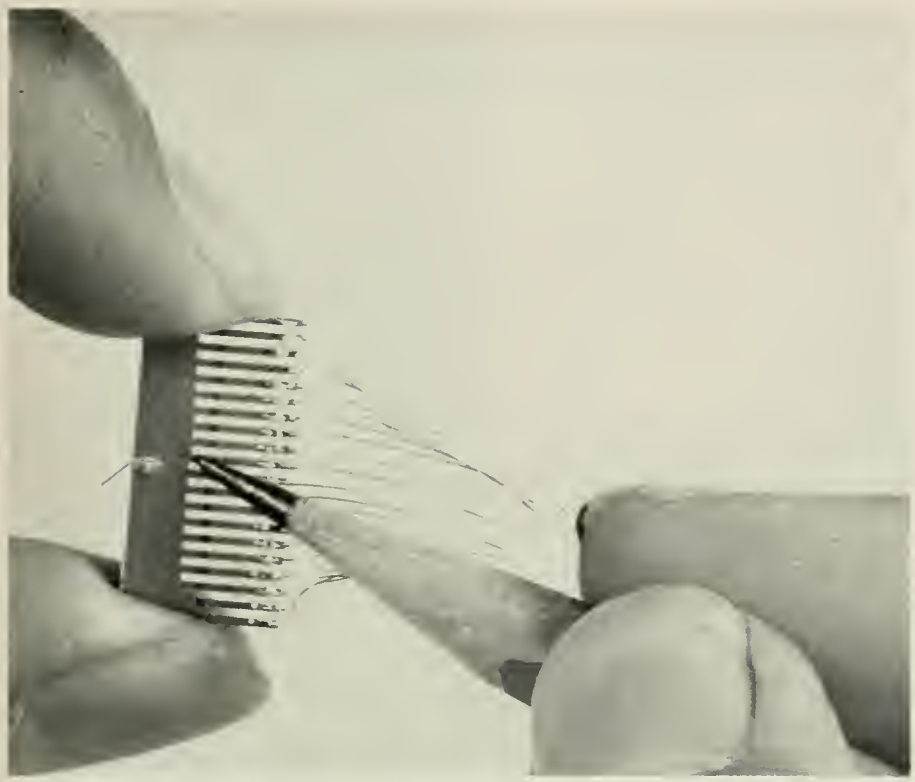
Are you inclined toward sales work? There are four main types of sales activity in the Du Pont Company—technical sales service, sales development, market research and direct selling. Information on sales, and many other facts about working with Du Pont, are given in "The Du Pont Company and the College Graduate." Write for your copy of this free 36-page booklet to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Building, Wilmington, Delaware.



Twenty light-and-heat sensitive cells are contained on a bit of glass ¾-inch long. The tiny black specks lying under the pencil point are the cells themselves.

jects without physical contact and over long distances.

Announcement of the availability of the Ektron Detectors culminates a decade of research by a team of scientists under Dr. G. W. Hammar. Though the cell reaches its peak of sensitivity in the invisible heat rays of the near-infrared, it is highly sensitive to all colors of visible light and on into the ultraviolet.

As a demonstration of the new cell, Kodak representatives have been exhibiting a small box that emitted squeals whenever the Ektron Detector on it "saw" the bit of hot ash on the end of a cigarette. It also squealed loudly when a flashlight was pointed at it with battery cells so weak that the lamp filament scarcely glowed.

In addition to its possibilities for heat detection devices and for the replacement of present types of "electric eyes" in rough-service applications, the Kodak company also sees a strong potential for Ektron Detectors in automatic control of chemical processing plant operations and in complex electrical equipment where mechanical switching devices are too bulky, impractical, or insufficiently reliable.

In the chemical plant applications, the cells could automatically monitor the exact composition of fluids flowing through pipes and process vessels on the basis of the characteristic infrared "color" of the various components. Water and gasoline, for example, are both colorless liquids to the human eye but look entirely different to a sensitive infrared detector. Very fine differences between chemicals can be detected in this way.

In the switch applications, say the Kodak engineers, the Ektron Detector permits a beam of light to eliminate a moving part. The "light," they point out, can come from a lamp operated so far below the rated current that the glow is invisible and lamp life is therefore unlimited. Ektron Detectors were shown at the convention June 14 in the form of multiple arrays of as many as 20 pinpoint specks of lead sulfide on less than an inch of glass. These are intended to operate complex combinations of electrical circuits in response to projected patterns of light or heat radiation.

Carilloy

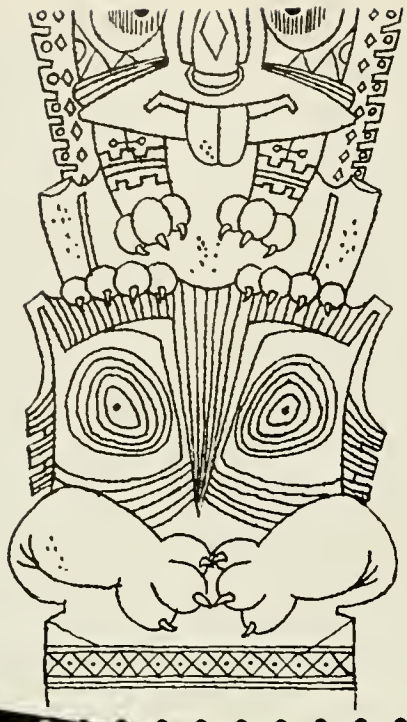
Coated with ice at 45 degrees below zero, four large closed pressure tanks of a new kind of steel were put through dramatic burst and impact test paces under a hot summer sun.

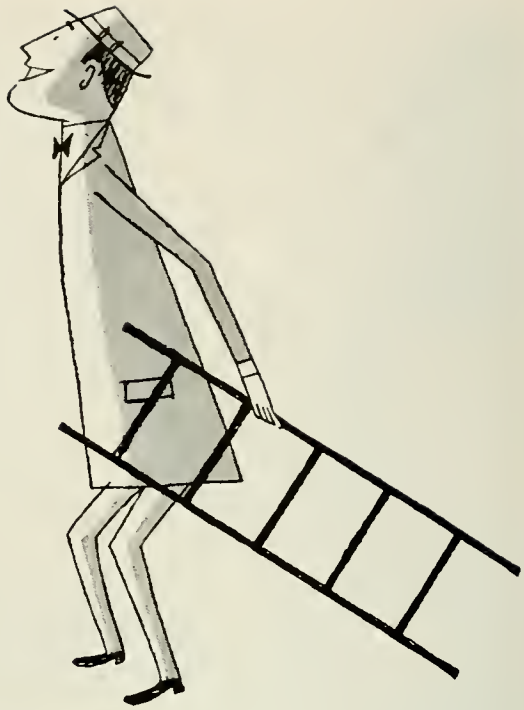
The vessels were made of a new quenched and tempered steel known as "Carilloy T-1." This new material is the product of United States Steel Corporation's Research Laboratory.

The tests were staged in an open area adjoining the plant of Chicago Bridge and Iron Company. Engineers and research experts of both companies took part in the series of tests before an audience of government and technical code authorities, representatives of the Atomic Energy Commission, army and navy officers, as well as the heads of military and civilian aeronautical groups.

"Operation T-1," as the test series was called, ticked off with the precision

Geyser of icy calcium chloride brine rises as big steel tank, frozen at 45 degrees below zero, is burst from internol pressure of 2,850 pounds per squore inch.





WE WANT MEN WHO HAVE AN EYE ON THE TOP OF THE TOTEM POLE!

NATURALLY, the reason for hiring any man at Columbia-Southern® is that we believe he is qualified for one of a variety of opportunities the Corporation offers. We want men for whom the first job is merely a starting point. We expect Columbia-Southern to continue growing and we want men who can not only grow with the company, but who can eventually contribute to the growth.

Ultimate advancement at Columbia-Southern does not depend on any particular type of technical training. Because Columbia-Southern's operations are primarily centered around chemical production and research, more chemists and chemical engineers seek employment than people with other kinds of training; more are hired and it is to be expected that more hold top executive positions; but the number in these top positions is not out of proportion to the whole.

Of the top 42 positions in the Columbia-Southern organization, for example, 24 are college graduates who majored in chemical engineering or chemistry. The other 18 are from fields as varied as civil engineering, forestry, mechanical engineering and business administration.

We believe Columbia-Southern is a good place to work and that it abounds in opportunity. Many of the graduates who have joined Columbia-Southern in recent years said they did so only after scouring the field. And their feeling is unanimous today that they made a wise choice.

If you have the urge to get ahead, we want you to look into our organization because one thing is certain: Columbia-Southern is going places. C'mon along.

For further information, write now, Dept. P at our Pittsburgh address or any of the plants.

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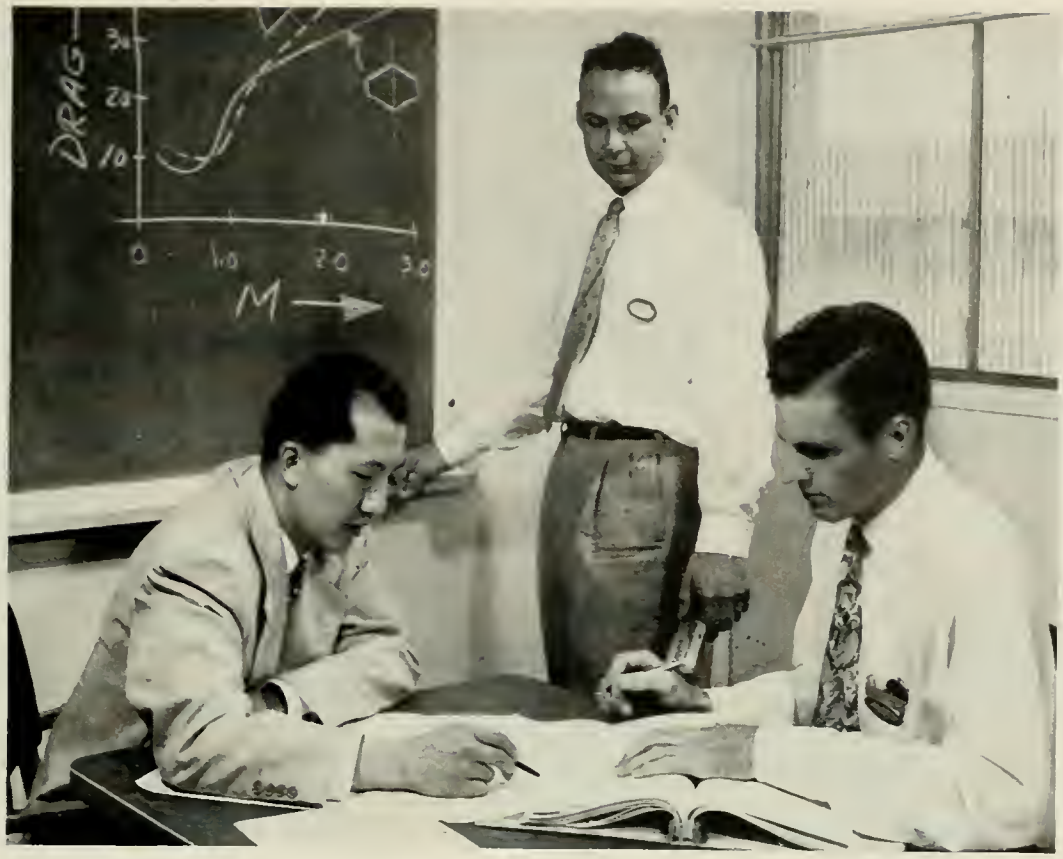

Jim Hong, *Aerodynamics Division head, discusses results of high-speed wind tunnel research on drag of straight and delta wing plan forms with Richard Heppe, Aerodynamics Department head (standing), and Aerodynamicist Ronald Richmond (seated right).*

Lockheed Expands Aerodynamics Staff

With five prototypes already in or near flight test, Lockheed's Aerodynamics Division is expanding its staff to handle greatly increased research and development on future aircraft in commercial and military fields.

The five prototypes, which show the breadth and versatility of Lockheed engineering, are: The F-104 supersonic superiority fighter; XFV-1 vertical rising fighter; C-130 U.S.A.F. turbo-prop cargo transport; R7V-2 U.S.N. turbo-prop Super Constellation transport; and an advanced jet trainer of the T-33 type.

New projects now in motion are even more diversified and offer career-minded Aerodynamics Engineers and Aerodynamicists unusual opportunity to: Create supersonic inlet designs for flight at extremely high altitude; match human pilots with rapid oscillations of supersonic aircraft at low altitude; develop boundary layer control systems for safe take-off and landing of fighters and transports; remove aileron reversal and tail flutter problems incurred in high speed flight through analysis and design; participate in determining configurations of turbo-prop and jet transports and advanced fighters, interceptors and bombers.

Career Positions at Lockheed

Lockheed's expanding development program has created a number of positions for Aerodynamics Engineers and Aerodynamicists to perform advanced work.

In addition Lockheed has positions open for Electronics Engineers, Thermodynamicists, Flight Test Analysis Engineers and Stress and Structures Engineers to perform advanced studies on such diverse projects as: Applications of nuclear energy to aircraft, turbo-prop and jet transports, bombers, trainers, supersonic fighters with speeds far surpassing those of present-day planes, and a wide range of classified activities.

LOCKHEED
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Program for Advanced Study — To encourage members of its engineering staff in study leading to advanced degrees, Lockheed reimburses 50% of the tuition fee upon successful completion of each course relating to the engineer's field at the University of Southern California and University of California at Los Angeles. Both universities offer a wide night school curriculum in science and engineering.

of a military maneuver, but behind the scenes long hours of hard work were required to bring the steel of the tanks down to the low temperature required. They were cooled by pumping into them hundreds of gallons of calcium chloride brine chilled by dry ice.

Two seperate test methods—burst tests and drop impact tests—were used to demonstrate the strength and toughness of the steel. Two burst tests were made on alternate days to determine how much internal pressure the tanks could withstand before they burst. In the drop tests a new method of testing full-scale vessels was used. A 26,700-pound steel weight was let fall upon the tanks from heights of 52, 73 and 101 feet to show the toughness of the steel at low temperatures. Internal pressure in the drop tests was 1,875 pounds were square inch.

Outwardly, when ready for the tests the four tanks appeared identical—20 feet long, including their hemispherical ends, and 48 inches in diameter, made from steel plates ½-inch thick, crusted with white frost, but the two tanks tested the first day were not "stress relieved," that is, they were in the natural condition, as welded. Those of the second day's tests had been "stress relieved" or given a special heat treatment following their fabrication so that internal stresses caused by the fabrication and welding were minimized. The objective was to compare how both kinds of tanks would react to the same tests.

Results of the tests performed on the four tanks were as follows:

1. Burst test non-stress relieved vessel at 45 degrees below zero, 2850 pounds per square inch internal pressure at moment of burst.

2. Drop test non-stress relieved vessel at 45 degrees below zero, 26,700-pound weight dropped from 101 feet caused break.

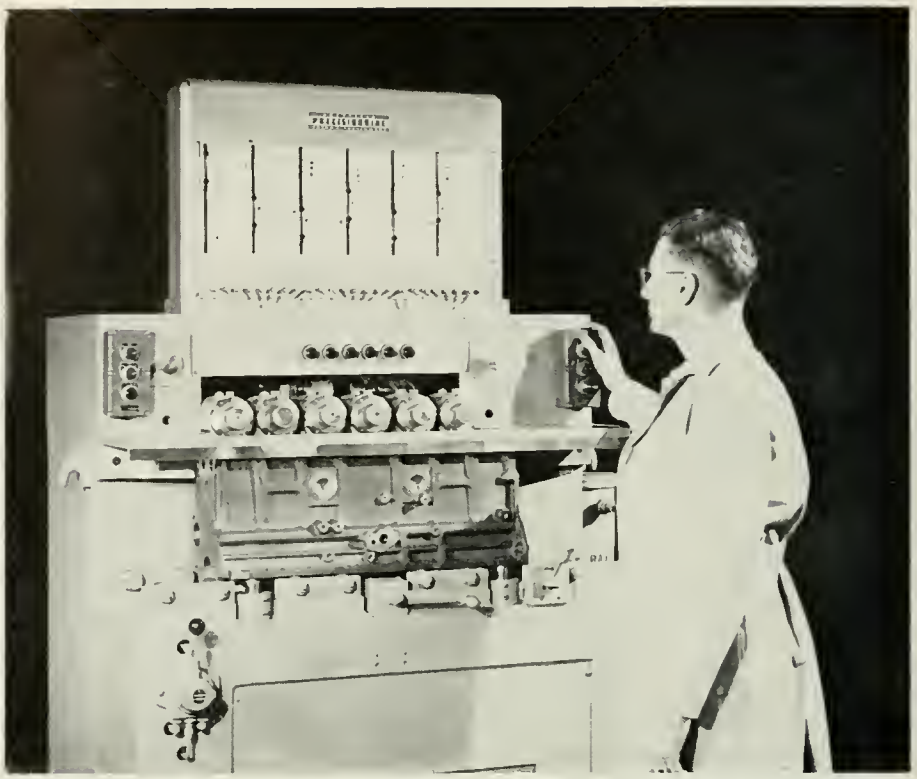
3. First test on stress relieved vessel at 45 degrees below zero, 2850 pounds per square inch internal pressure at moment of burst.

4. Drop test on stress relieved vessel at 45 degrees below zero, 26,700-pound weight dropped from 101 feet caused break.

At intervals throughout the test periods girth measurements of the tanks were made and recorded to show swelling and deformation.

Results of the burst and drop tests were spectacular. The steel showed tremendous toughness even at the very low test temperature. Yellow calcium chloride brine gushed like a geyser from a hole burst in the tank.

When the drop tests were completed the tanks had amply demonstrated their ability to withstand tremendous shock.



This model of an automotive cylinder bore gaging ond classifying machine is the lotest addition to the automotive industry with a rated copacity of two engine blocks per minute.

Bore Gaging Machine

Two engine blocks per minute! That's the rated capacity at 100% efficiency of the latest model automotive cylinder bore gaging and classifying machine designed and manufactured by the Sheffield Corporation.

This unique machine is used to simultaneously measure and classify bore diameters in a six cylinder engine block, to inspect out-of-roundness and taper, and to stamp the classification of each bore on the block. Bore are divided into 10 classes with a .0003 difference between each class. Classifying bore diameters in this manner permits selective matching of pistons to bores during assembly.

Six air spindles, each having two diametrically opposed air jets at four positions along its length, are motorized for rapid travel into and out of the block. They explore the bores to full depth. Each pair of air jets is connected to a glass column in the 24 column Precisionaire. The positions of the floats in the Precisionaire instantly indicates any taper, out-of-roundess, or deviation in diameter. A semi-automatic stamping device mounted above each bore marks the bore class on the block opposite each bore.

If, on occasion, a bore may taper too much or contain an obstruction restricting the upward movement of the air spindle, the cycle is stopped automatically and a red light indicates the faulty bore.

When the spindles are fully extended into the bores, a manually operated lever may be used to rotate them simultaneously 180 degrees to check out-of-roundness. Taper is indicated by comparison of four float positions for each of the six cylinder bores.

God made a machine, the machine made men,
Doctors, lawyers, priests, and then,
The devil got in and stripped the gears
An turned out the first batch of engineers.

* * *

The difference between a dress-tie and a noose is that one is worn without a collar.

* * *

Clergyman—A man who works to beat hell.

* * *

Mary: "Boy, you have to hand it to Bill when it comes to petting."
Betty: "Why, is he lazy?"

* * *

Say it with flowers, say it with sweets,
Say it with kisses, say it with eats.
Say it with jewelry, say it with drink,
But never, oh never, say it with ink.

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Rollpin is driven into holes drilled to normal production-line tolerances.

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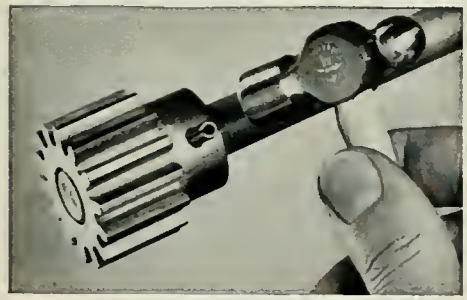

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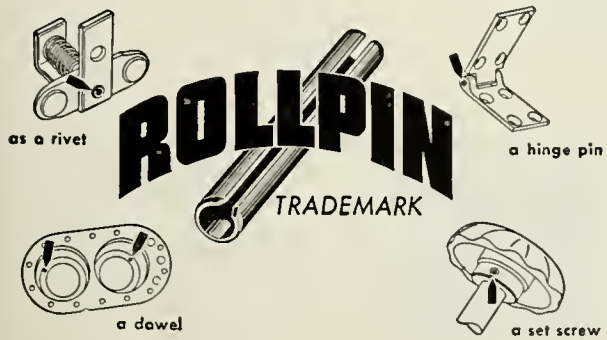
If you use locating dowels, hinge pins, rivets, set screws—or straight, knurled, tapered or cotter type pins—Rollpin can cut your costs. Mail our coupon for design information.



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The Senior Staff of The Ramo-Wooldridge Corporation, shown above, is comprised of scientists, engineers, and science administrators with outstanding records of past performance in positions of responsibility. By means of meetings of the entire group, supplemented by frequent smaller sessions, these key men participate actively in the establishment of company plans and policies.

Existing project commitments require that the current rapid rate of expansion of the company continue throughout the coming year. Unusual opportunities, encompassing a wide variety of challenging research and development problems, exist for *additional* scientists and engineers who would like to participate in the development of a company in which, from the outset, all features of the organization and of the operational procedures are designed to be as appropriate as possible to their special needs.

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- Business Data Systems Development
- Radar and Control Systems Development
- Communication Systems Development

Theory Versus Practice

by Loyal Clarke

It has long been known that theoretical developments lead eventually to new practices in industry. This was impressed on me in my college training. Experience has strengthened this conviction.

Why eventually? Why not now? Why should there so often be such a wide gap between theoretical progress and its practical application?

Shortly after graduation I made a number of suggestions to a stubborn practical engineer. Whether the suggestion was good, bad, or indifferent, his comment was always, "That's good in theory but not in practice." So one day I replied, "If something is really good in theory, it is good in practice; if the theory is right, practice is wrong; if practice is correct, the theory is wrong. A theory that does not improve practice is useless." He replied, "Then there must be a lot of rotten theories." There are indeed a lot of incorrect or misleading theories. Even a good theory can fail because of its improper usage. A proper application cannot be made unless the theory applies to plant conditions and takes economic factors into consideration.

What are the pitfalls for application of theory? Occasionally, a theory may be entirely correct. More often it is not sufficiently complete. The ideal conditions for which it was derived may differ considerably from plant conditions and therefore not apply. Still more often good theories are manhandled, i.e., improperly used. I'll have more to say about these later. First, let's talk about the most common pitfall of all.

Failure to fully consider costs has led to countless disasters.

A classic example is the story of a tung oil pressing plant built in China back in the "twenties." For centuries the Chinese coolies had been pressing tung oil by driving wedges into logs, putting seeds into the split, and then removing the wedges. A young chemical engineer reasoned, correctly, that this was a poor method of pressing—high labor and low yield. So he built a modern hydraulic pressing plant and went broke. His power, maintenance, and capital costs far exceeded the costs of Chinese coolie labor.

Yes, this was a freak condition, but the same type of thing often happens in our modern industry. The large Fischer-Tropsh plant was recently shut down at a loss of, perhaps, $75,000,000. Just a few years ago another petro-chemical plant failed and several millions of dollars were lost.

What is efficiency? Any engineer can define the mechanical efficiency of a pump. Is a pump of the highest mechanical efficiency the most efficient to install? Probably not. The management is interested in the total cost of the operation. This total cost includes operating labor, maintenance, interest or borrowed capital. Thus, in some instances a cheap pump would be chosen. In others an expensive pump would be chosen with special features such as mechanical seals or corrosion-resistant alloys. In any event the mechanical efficiency is only one of many factors.

A practical plant criterion is "the most for the least." This, in my opinion, is equally sound in theory. Acceptance of this philosophy means that power is frequently sacrificed to lower capital costs or to reduce maintenance. A particular type of efficiency is sacrificed to save money. What does this saving in money represent? It means less steel, fabrication labor and operating labor: it allows better utilization of available capital. To put this another way, the average efficiency in the use of all our country's resources can be improved by tempering the desire for particular forms of efficiencies to improve others. Cost factors, properly used, afford a reasonable measuer of the overal efficiency.

A theory may be correct but not sufficiently general to apply as we might wish. When I went to college we were given a formula for filtration rates, a useful formula that gave satisfactory results for most cases. The filtration of some solids (such as those removed from vegetable oils) completely ignored the theory. Why? The formula was based on an incompressible cake but some solids form compressible cakes. Since then, theory has been extended to include allowance for the missing factor.

Shortly after marriage I told my wife not to boil the potatoes so fast. Since water boils at 212°F the potatoes would cook equally fast if boiled slowly. She promptly demonstrated that potatoes cook faster when boiled rapidly. Agitation by rapid boiling improves the heat transfer.

It is common practice to design coolers and heaters from theoretical calculations. This acceptance is natural because the calculated rate of heat transfer is nearly always within a few per cent of that observed for new equipment. After a limited period of service, the rate may drop due to solid forming deposits on the tubes, shutting down an operation before the scheduled shutdown period. This would increase maintenance costs and upset the general maintenance shop schedules. The reduction of heat transfer by fouling is not susceptible to theoretical treatment, but empirical fouling factors have been developed from experience and acceptd by theoretically minded people. Many such factors of safety are used in equipment design and specifications.

Thus before an application of theory is attempted careful consideration of a number of factors should be made. Care should be taken that the theory is applicable to the actual conditions. Proper safety factors to cover any uncertainties should be included. Finally, an overall benefit for the ultimate objective must be shown. A better product at low cost is the most common objective.

Modern industry is complex and it is seldom that one person can evaluate all the ramifications of even his own ideas. Rather, a new idea is turned over to many people. One should welcome this review even though often the idea may receive unfair treatment. More often, the reviewers will reject the idea because it has disadvantages that were not at first evident. It may be a good idea but just a little short on economic advantage and therefore be sidetracked for more promising developments.

Unfair treatment of new ideas is indeed common—some people are downright prejudiced against new ideas other than their own. Others are too conservative and very hesitant in approving new projects even after it has been demonstrated that the project looks favorable and is a good "calculated risk" for capital investment.

How can we combat this prejudice and inertia? I think it is a hazard of our trade, something that we must live with. At least, we can do much to minimize it and can make much progress, despite the inertia, through patience and understanding.

Consider an engineer who has developed a new process and had the pleasure of seeing it operate satisfactorily and make money. Of this he should be proud. Unless he is unusually broad minded, this pride may blind him to the possibilities for improvement and to the weakness of his past work. During the course of development he probably tried many ideas that failed. He knows that a new idea represents a new gamble and unless

the expected benefits are very high indeed, he may be slow to take the gamble. When the plant is in trouble or a new process is to be installed, then the same man will show interest in new ideas. At those times of dire need, the men with good ideas have a good opportunity to secure the confidence of the hard-bitten administrators. At times like these a file of ideas is valuable. Then, too, there are very few so completely opposed to change as they first appear. Indeed no one can maintain a reputation by rejecting all progressive ideas.

So, by a reasonable balance between patience and impatience you, who are full of new ideas, can look forward to seeing many of them put into practice. You can best promote an idea if you give careful consideration to all competing theories, practical aspects, and weak points before advancing it and then listening eagerly to the comments. Careful listening may permit still further improvement. One who suggests an improvement should be as zealous in improving his own ideas as he is in changing another's. Most of all, keep plugging and don't allow any kidder or vicious plant engineer to destroy your initiative. All too often young engineers are "beat down" during their training period. They too follow only "the book" of standard practice and become just the type that they had earlier detested.

Sure I know that it is discouraging to see good ideas shoved unceremoniously into the waste basket, or to be told that your idea had been rejected five years earlier. So what? You have many years ahead, and many, many more disappointments mixed with your achievements.

As a further example, permit me to reminisce over an old friend and former boss of mine, the late Mr. J. L. Schlitt. He once said in jesting "It doesn't make any difference whether we hire a chemist, a chemical engineer, or a mechanical engineer, it still taks him five years to learn that the piping costs too much." This has all the ring of a remark of a hard-bitten practical man. Yet, he was one of the most profoundly theoretical men that I have known. He designed a complete ethylene separation unit involving the closely interlocked operation of four distillation columns, two refrigeration systems, many heat exchangers and enough instruments to fill a thirty-foot panel. This was a paper design based on somewhat incomplete data. Yet, as designed, the pilot plant made 99.8% ethylene at 85% recovery, meeting design conditions. It was difficult to put the plant in operation and its control was sensitive, so he reached into his file of calculations, already prepared for such contingencies. From about twenty possible alternates, he chose two involving minor alterations. These two changes were made and no more were ever needed. Yes, Mr. Schlitt knew his theory. He knew it so well that he appreciated all its limitations and uncertainties.

During my lifetime I have seen many reconciliations of theory and practice and many failures. I believe that the competition between the two has become less bitter and more friendly.

Probably the competition will never end; but this is good, for the reconciliation of theory and practice affords a continuing challenge to engineers of all ages.

SOLUTION:

How Many Cigarettes?

If n is the number of cigarettes which the Chesterfield man now has, then $2\frac{1}{2}n + 2\frac{1}{2}$ is the number he originally had. A check on the possible values of n shows that there must originally have been either 15 or 20 Chesterfields. If there were 20 Chesterfields, then $n = 7$ and 13 Chesterfields are smoked. This is impossible since the man who smokes Luckies smokes 2 more, doesn't smoke his total supply, and can not have more than 15. Therefore, there are 15 Chesterfields. Ten Chesterfields are smoked. This means that there must be more than 12 Luckies. The only possible number is 20.

Reilly must have either 6 or 8 cigarettes, since he must smoke half of them and more than half of the 20 are smoked. Five Kools (the only tipped cigarette in the group) are smoked. Therefore Reilly must smoke 4 of the 8 cigarettes he started with. Turner starts with 6 Kools.

Brown has 3 cigarettes due to the limited number of aces in the deck. The man who has 20 Luckies is not Perkins and therefore must be Jones. Perkins will have 15 Chesterfields. Brown does not smoke Camels (from statement 8) and therefore must smoke Old Golds. Reilly smokes Camels.

Name	*Number*	*Brand*
Brown	3	Old Gold
Perkins	15	Chesterfield
Turner	6	Kool
Jones	20	Luckies
Reilly	8	Camel

HOW A COMMON HOUSEHOLD PROBLEM INSPIRED A 19TH CENTURY TOOLMAKER

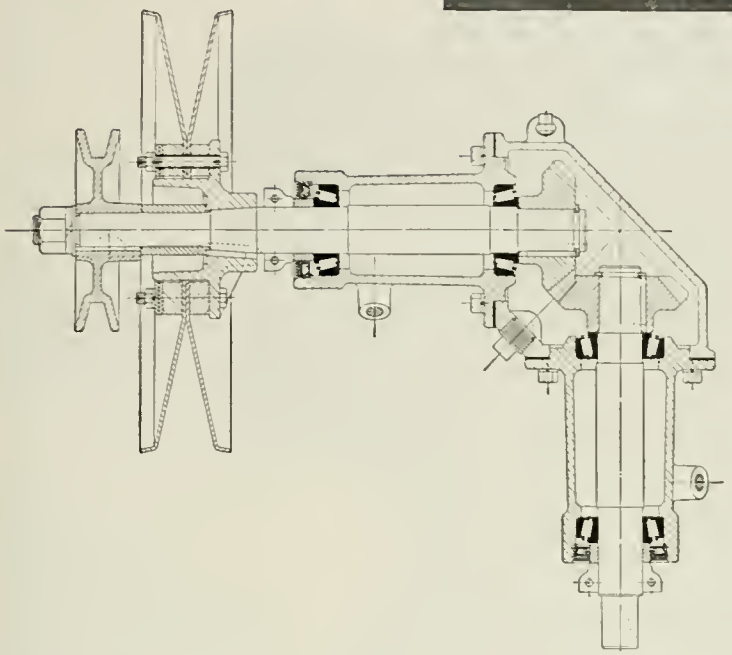
The candle that doesn't fit into the candle-holder has long been an annoyance to householders. This problem was taken up early in his career by Joseph Whitworth (1803-1887), great Manchester engineer and toolmaker—later, Sir Joseph Whitworth—who was probably the first British engineer to preach standardization as a means of obtaining interchaneability. Whitworth illustrated his thesis by pointing out a need that everyone could feel and understand—the need of standard sizes for candle-butts and candle-sticks.

Whitworth later developed a system of standard gages that was widely used in British industry. In 1841, in a paper read before the Institution of Civil Engineers, he urged the adoption in Britain of a uniform system of screw threads in place of the various different pitches and dimensions then used. His thread design became known as the Whitworth Thread and was adopted both in Britain and on the continent.

In 1948, after more than thirty years of negotiation, America, Britain, and Canada agreed to merge the Whitworth Thread and the American Standard Thread into a Unified System of Screw Threads. It is the thread now used in virtually all military equipment and in most of the civilian goods produced by the three countries.

Candle-butts and candle-sticks have been standardized to some degree, but time and technology have made this problem somewhat less acute than it was when Whitworth studied it in 1830.

Another page for **YOUR BEARING NOTEBOOK**

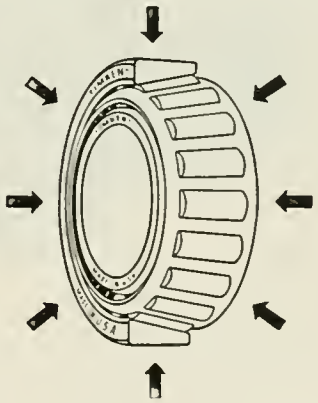


How to increase bevel gear life

The shafts that hold the bevel gears in this farm machine gear box carry two kinds of loads. Loads from the bevel gears run 1) along the shaft and 2) at right angles to it. Timken® bearings, being *tapered*, carry both loads at once, hold gears rigidly in place. Perfect tooth-mesh is maintained; gears last longer.

How TIMKEN® bearings hold shafts rigid

The line contact between rollers and races of Timken bearings gives shafts rigid support over a wide area. Shaft deflection is minimized. And end-play is eliminated because the tapered design of Timken bearings lets them take radial and thrust loads in any combination.



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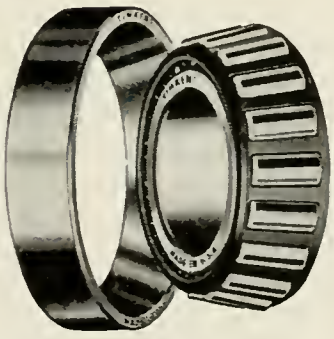
TAPERED ROLLER BEARINGS



Want to learn more about bearings or job opportunities?

Many of the engineering problems you'll face after graduation will involve bearing applications. For help in learning more about bearings, write for the 270-page General Information Manual on Timken bearings. And for information about the excellent job opportunities at the Timken Company, write for a copy of "This Is Timken". The Timken Roller Bearing Company, Canton 6, Ohio.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⦶ AND THRUST —⦶— LOADS OR ANY COMBINATION ✳

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This is the front door to one of the most exciting developments in the aircraft industry today... the development of a top team of Martin scientists, physicists and engineers to carry on a planned, long-range, top secret program.

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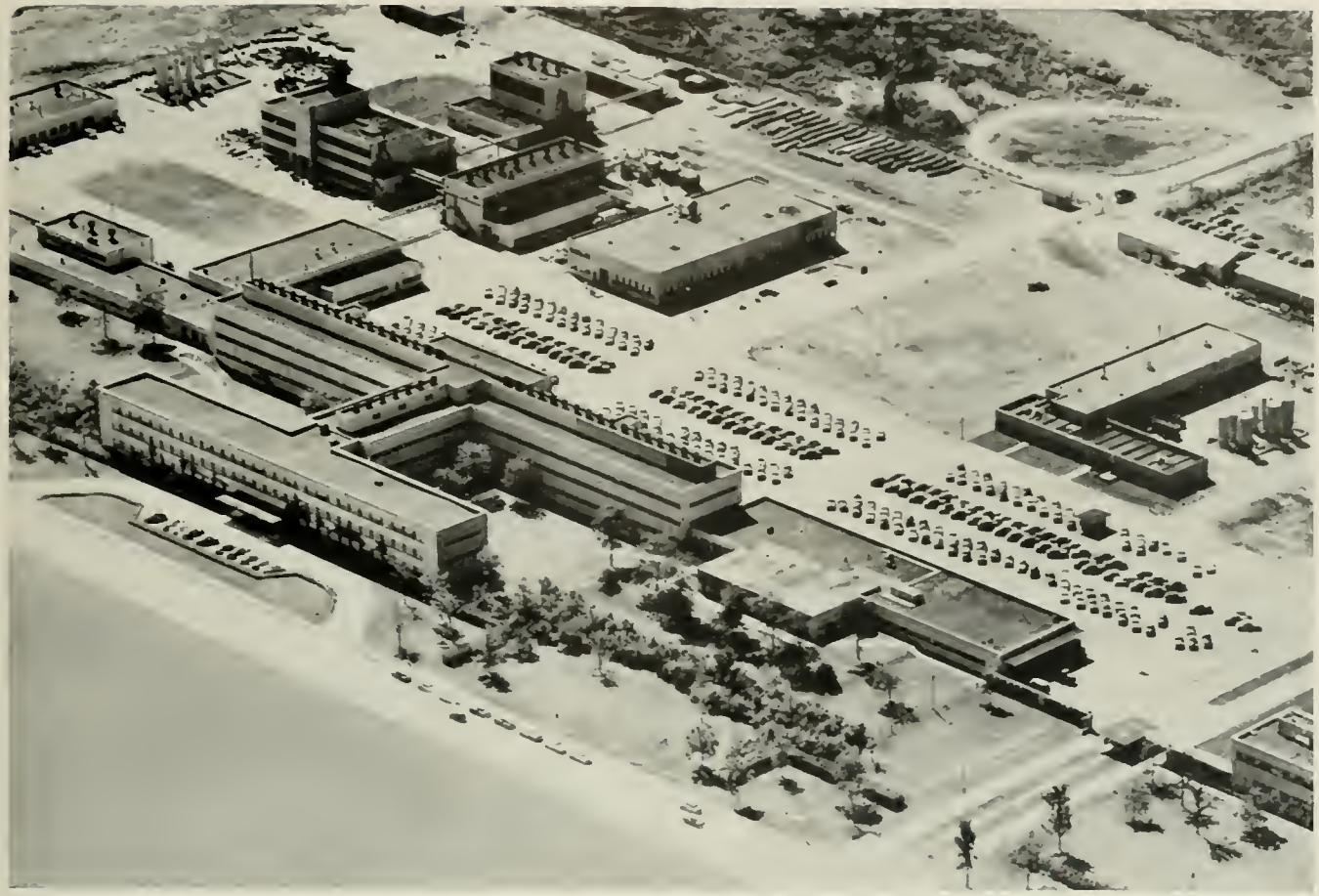

MOST OF THE RESEARCH WORK that led to the development of Ultraforming—a more efficient and economical refining process—took place in the Whiting research laboratories of Standard Oil, above. Extensive studies in seventeen research-scale units demonstrated the merits of cyclic regeneration.

Standard Oil scientists develop **Ultraforming--** the latest in catalytic reforming

After several years of research, Standard Oil scientists have developed a new and important refining process—Ultraforming.

The process is a better way of improving the low-octane straight-run gasoline found in crude oil. To make such gasoline suitable for present day cars, refiners must change it into an entirely different material, which gives good anti-knock performance. The change is known as reforming.

Ultraforming is the last word in catalytic reforming. It gives greater yields of higher octane gasoline than were previously possible and gets good results even with poor feed stocks. In addition, it raises the yield of hydrogen, an increasingly valuable by-product of catalytic reforming.

Ultraforming units do not have to be shut down when the catalyst begins to lose activity through use. By a new technique, an improved platinum catalyst is regenerated to maintain peak performance.

The advantages of Ultraforming over previous methods are so great that Standard Oil and its subsidiary companies are building units at four refineries. They will start operating this year. The new process, of course, is available to the petroleum industry through licensing arrangements.

At Standard Oil, young engineers and chemists work with the stimulating knowledge that they are participating in important and lasting contributions to the oil industry and to their country.

Standard Oil Company

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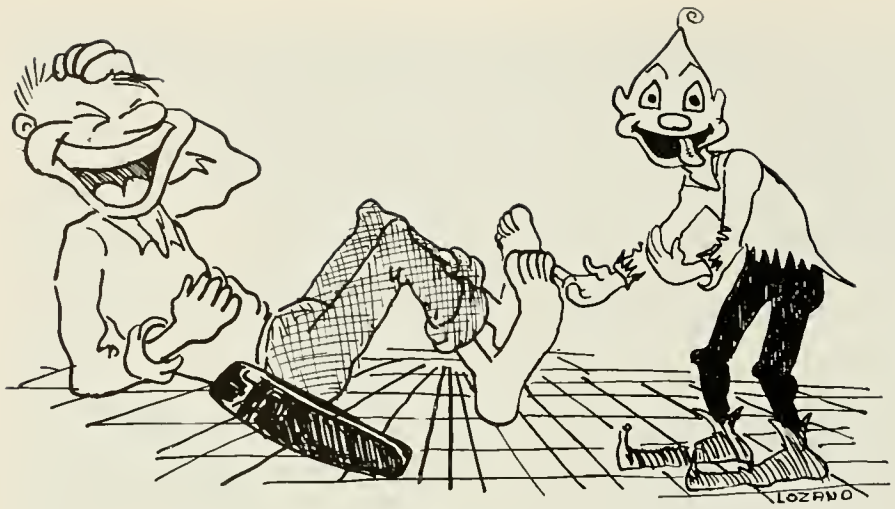

TECHNOCRACKS

THE CHAMPION

Three small boys were bragging about the prowess of their dads. The first boy said: "My dad writes out a few short lines, calls it poem, sends it away and gets ten dollars for it."

"My dad," spoke up the second lad," makes some dots on a piece of paper, calls it a song, sends it away and gets twenty-five dollars for it."

That's nothing," spoke up the third, "my father writes a sermon on a sheet of paper, gets up in the pulpit and reads it and it takes four men to bring in the money."

* * *

In the days of Queen Elizabeth 'tis said, some of the ladies of the court liked to curl up with a good book, while others preferred individual pages.

* * *

Temperance lecturer: "And in conclusion, my dear fellows, I will give you a practical demonstration of the evils of liquor.

"I have here on the table two glasses. One is filled with whiskey, the other is filled with water. I will now place an angle worm in the glass of water. See how it lives, squirms, vibrates with the very spark of life?

"Now, I place a worm in a glass of whiskey. See how it curls up, writhes in agony, and finally dies. Now young man," pointing to a student in the front row, "what moral do you get from this story?"

McKenzie: "If you don't want worms, drink whiskey."

* * *

Someone remarked the other day that a debutante is just a young tomato with lots of lettuce.

Carl: "What is the most beautiful thing in the world?"

Tom: "I say a beautiful woman is the most beautiful thing in the world."

Ben: "I claim that sleep is the most beautiful thing."

Carl: "Ah, next to a beautiful woman sleep is."

* * *

She was a secondhand-furniture dealer's daughter. That's why she wouldn't allow much on the davenport.

* * *

Then there's the little farm girl who always went out with city fellers because farm hands were too rough.

* * *

Miss: "I told him that I worshipped my figure, and he tried to embrace my religion."

* * *

Teacher: "Now, Johnny, if I lay two eggs here and three over there, how many will there be all together?"

Johnny: "Personally, I don't think you can do it."

* * *

"Let's make a date for Saturday."
"I have a date for Saturday."
"Then let's make it Sunday."
"I'm going out of town Sunday."
"How about Monday?"
"Oh, hell, I'll go Saturday."

* * *

"Now that we're engaged, darling, you're going to give me a ring, aren't you?"

"Sure kid, what's your phone number?"

Any person who claims that it is impossible to attain absolute zero hasn't taken a quiz in thermo lately.

* * *

In golf, it's distance.
In a cigarette, it's taste.
In a Crosley, it's impossible.

* * *

Engineering students are baffled by the fact that often the girls with the most streamlined shapes offer the most resistance.

* * *

If every boy in the U. S. could read every girl's mind, the gasoline consumption would drop off fifty per cent.

* * *

We heard about a wedding where the bride carried Four Roses—rather well.

* * *

Prof. Yanosik: "Give me an example of an imaginary spheroid."

M. E.: "A rooster's egg."

* * *

She: "My lawyer told me to say No to everything."

He: "Do you mind if I hold your hand?"

She: "No."

He: "Do you mind if I put my arm around you?"

She: "No."

He: "We're really going to have fun if you're on the level about this."

* * *

June (a bride) was showing her uncle over their new home.

"This is my room, Uncle. You see we have twin beds: they are so much more hygenic. That is Harry's and this is mine."

Then the uncle noticed a blue china clock on the mantel and remarked, "What a charming clock."

"Yes," replied June, "it's a wedding present from dear Grandma."

A few weeks later the uncle received a note from June telling how the blue clock had disappeared the very afternoon he was there. Could he throw any light on the subject?

The uncle answered by return mail. "Dear June, look in Harry's bed."

* * *

A fellow we know has a broken arm received for fighting for a woman's honor. It seems she wanted to keep it.

* * *

Student: "How is steel wool obtained?"

Professor: "By shearing hydraulic rams."

PHOTOGRAPHY AT WORK—No. 12 in a Kodak Series

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When photography peered inside... the battery shrank in size...lasted longer

Radiograph showing how anode grows in use. From such facts, National Carbon developed a battery with the largest possible anode in a small case.

In air-depolarized hearing-aid batteries, anode size determines battery life. But anodes swell in use. How big could one be for a tiny new case? National Carbon Company used x-rays and photography and found out.

NEW electronic developments were making hearing aids more effective, smaller, more convenient. What was needed was a power supply equally advantageous. Could this be had without sacrifice in battery life?

National Carbon Company thought so—put x-ray photography to work—and came up with a mighty midget "Eveready" with unusually long life.

Checking internal conditions like this—proving the soundness of castings and welds—inspecting the inside of "sealed-in" assemblies—are all in the day's work for photography.

In fact, graduates in the physical sciences and in engineering find photography an increasingly valuable tool in their new occupations. Its expanding use has also created many challenging opportunities at Kodak, especially in the development of large-scale chemical processes and the design of complex precision mechanical-electronic equipment. Whether you are a recent graduate or a qualified returning serviceman, if you are interested in these opportunities, write to Business & Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.

Eastman Kodak Company, Rochester 4, N. Y.

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A young man who can lead has always had a good chance of success, but his prospects were never better than now. There's a steadily growing demand in industry for men to fill top professional and management jobs . . . fellows with a special ability to work well with other people and inspire their best work. At General Electric, we're constantly on the lookout for them.

Ten traits we look for, above, add up to a pretty good indication of potential success in business. Not everyone has them all to a top degree, but the basic characteristics are always present and can be developed in the men we pick to help lead General Electric. We hope you can rate yourself very high on the list and find it helpful.

EDUCATIONAL RELATIONS, GENERAL ELECTRIC CO., SCHENECTADY, N. Y.

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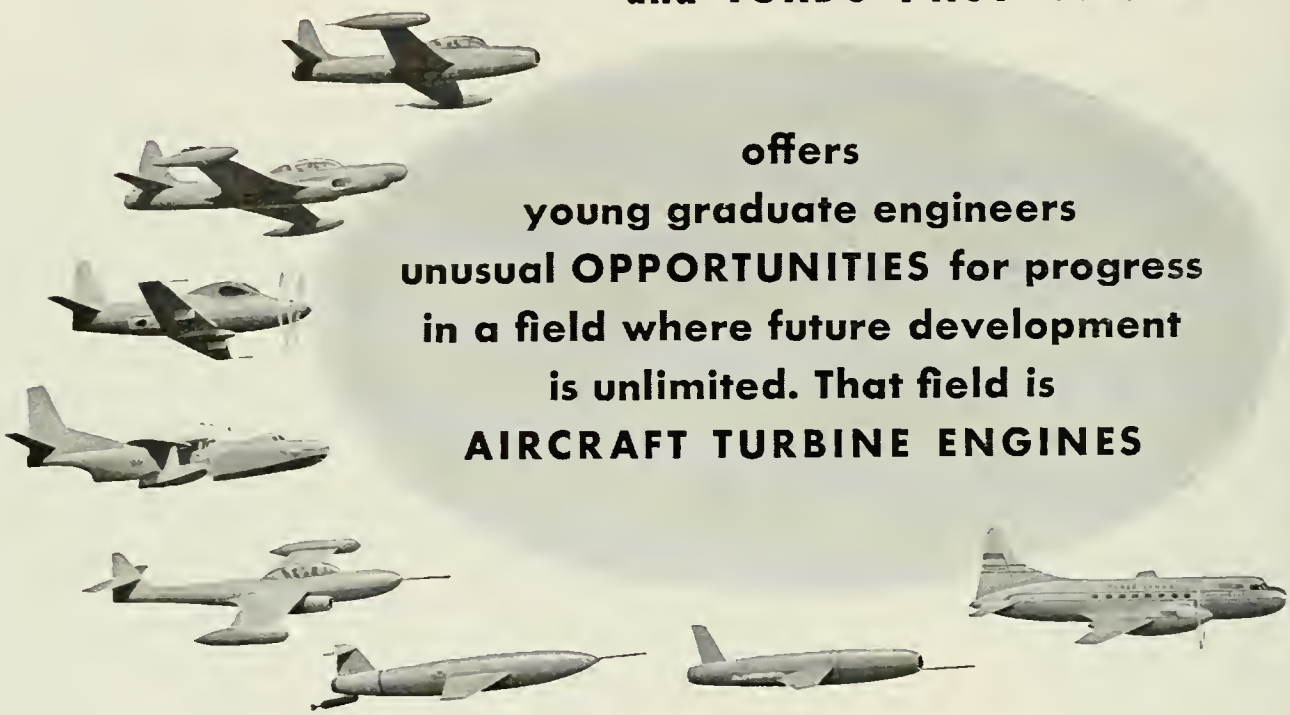

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Easy Money . . .

I'd like to give you a few hints on how to make some easy money. The Technograph is sponsoring a contest open to all persons not on the Technograph staff. To win you must submit an article on engineering to our office before March 1, 1955. The prize is fifty dollars and your article printed in the Technograph. If you don't think you can win, you have nothing to lose and everything to gain. Even if you don't win, you have a very good chance of having your article printed in the Technograph.

Have you just written a seminar report? Are you planning to write one? This is a good chance to kill two birds with one stone. A seminar report can be pretty technical and is directed to seniors in your field. Please be very explicit and try to keep from getting to deep to be of interest to everyone. It is easy to point out the uses of a discovery to keep a paper from being dry.

When writing, remember that you have something to tell your audience. You know about the subject but the reader may not. He must be able to understand what you have to say. You are influencing some high school student as to what career to choose.

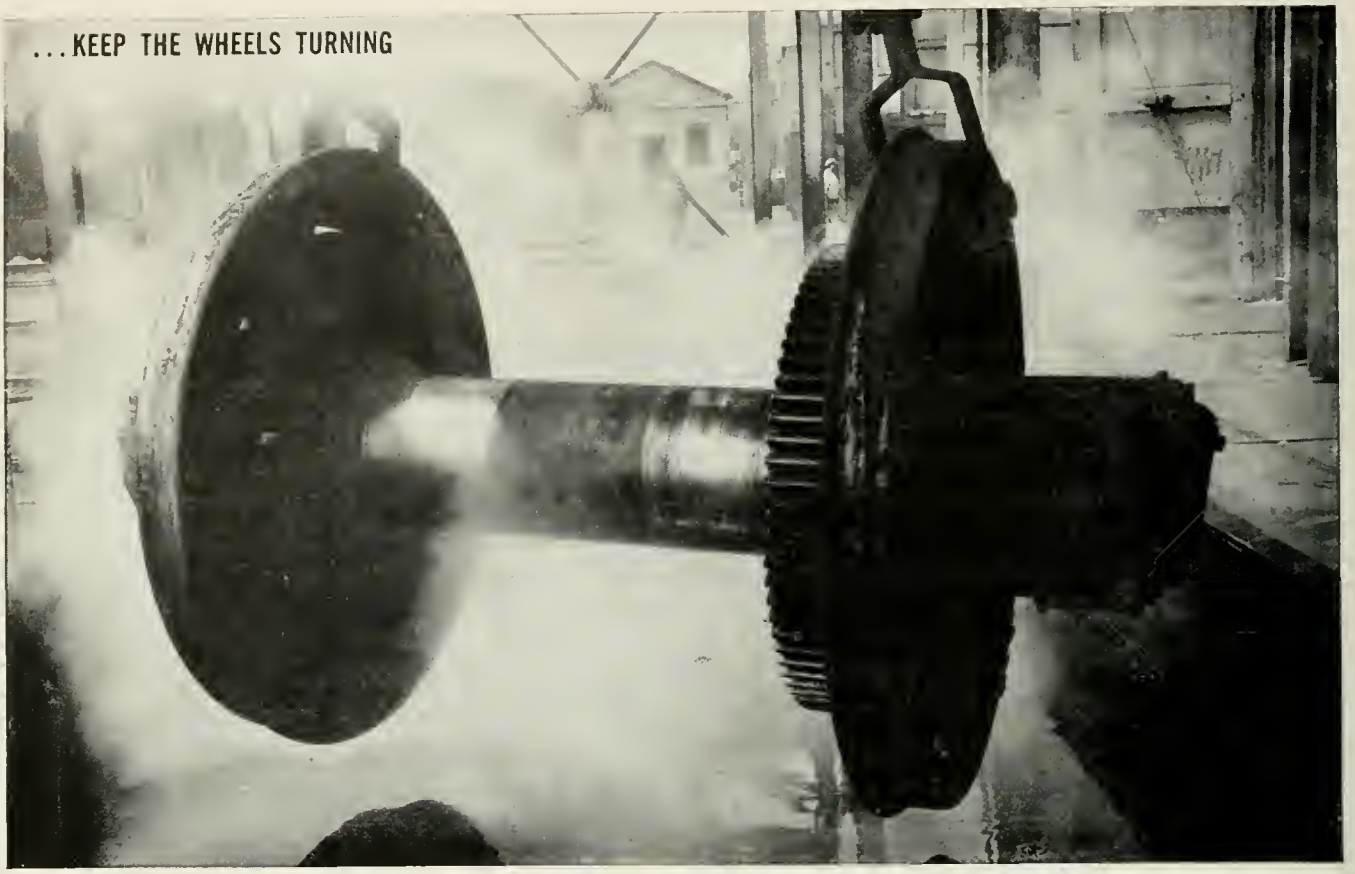
We welcome articles or suggestions from anyone, high school students included, as to what kind of articles you want, or any other kind of improvement.

Ten typewritten pages makes about three pages in the magazine. Be sure to include pictures to attract interest. Excessively long or short articles are not very useful. Any number of articles may be submitted by one author. Remember, you are not competing with Technograph staff writers. They have a contest of their own.

Any national company will be glad to give you pictures and material about their industry. It will probably take two weeks to get them so start now. It is not necessary to give credit for the material, but credit must be given under the pictures. Please write your own captions for the pictures.

Good luck to you on all your attempts. Get started now or you will forget.

D. F. K.



CHEMICAL BATH—Hercules Dresinate®, added to alkaline cleaners, increases the efficiency of cleaning solutions for large equipment such as these railroad wheels. In other applications—as an emulsifier, detergent, dispersant, foaming and flotation agent—this water-soluble resinate helps increase performance, reduce cost of other compounds.

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Most businesses are helped today by Hercules' business . . . the production of synthetic resins, cellulose products, chemical cotton, terpene chemicals, rosin and rosin derivatives, chlorinated products, and many other chemical processing materials—as well as explosives. Through close cooperative research with its customers, Hercules has helped improve the processing or performance of many industrial and consumer products.

VERSATILE RAW MATERIAL—The linters left on cotton seed are made into chemical cotton (bleached cotton linters) by Hercules' Virginia Cellulose Department. In high-grade paper, chemical cotton replaces rags, eliminates costly rag sorting. And chemical cotton is the best source of cellulose, key to products ranging from lacquers to plastics.

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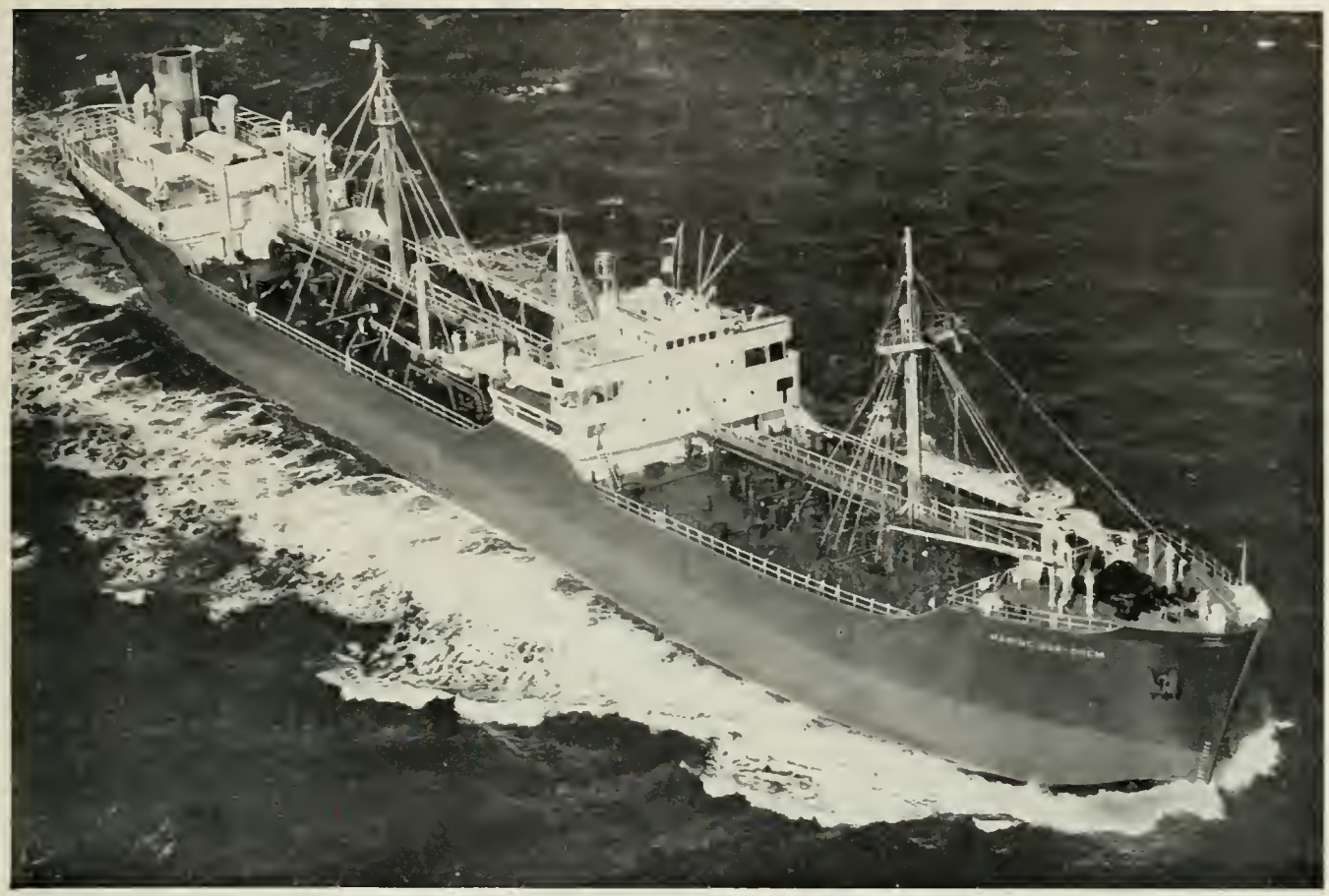

S. S. Marine Dow-Chem, first ship ever built specifically for the transportation of liquid chemicals.

CHEMICALS GO TO SEA...

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Newest link between Dow's important Texas Division and eastern terminals is the 18,000-ton chemical tanker, "Marine Dow-Chem". First ship ever designed and built to carry chemicals, this huge tanker has a capacity of 3,500,000 gallons, including special nickel-clad, heated tanks that safely carry 73% caustic soda solution. The "Marine Dow-Chem" made her maiden voyage in April, completing three years in the planning and building of the vessel.

Transportation of Dow chemicals by way of water routes did not begin with this new ship. Dow has pioneered in this technique of shipment. On any given day, you may see a tanker steaming out of Freeport, Texas, steering for East Coast terminals; a powerful tug herding its charge of barges up the Mississippi to Cincinnati; and a freighter leaving California, heading through the Panama Canal toward the Atlantic coast. All have one common purpose —delivering Dow chemicals by the most convenient, most economical routes possible.

Just as Dow's research and production are making giant steps in the progress of the chemical industry, so Dow's distribution keeps pace through new techniques in transportation and service.

Whether you choose research, production or sales, you can find a challenging career with Dow. Write to Technical Employment Department, THE DOW CHEMICAL COMPANY, *Midland, Michigan or Freeport, Texas for the booklet, "Opportunities with The Dow Chemical Company" – you'll find it interesting.*

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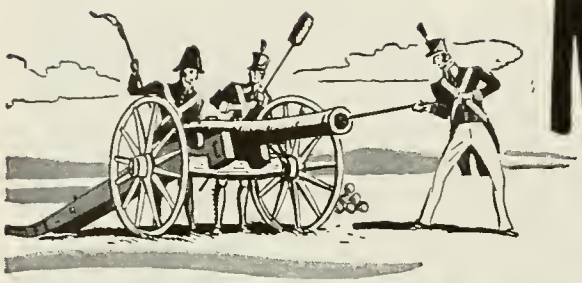
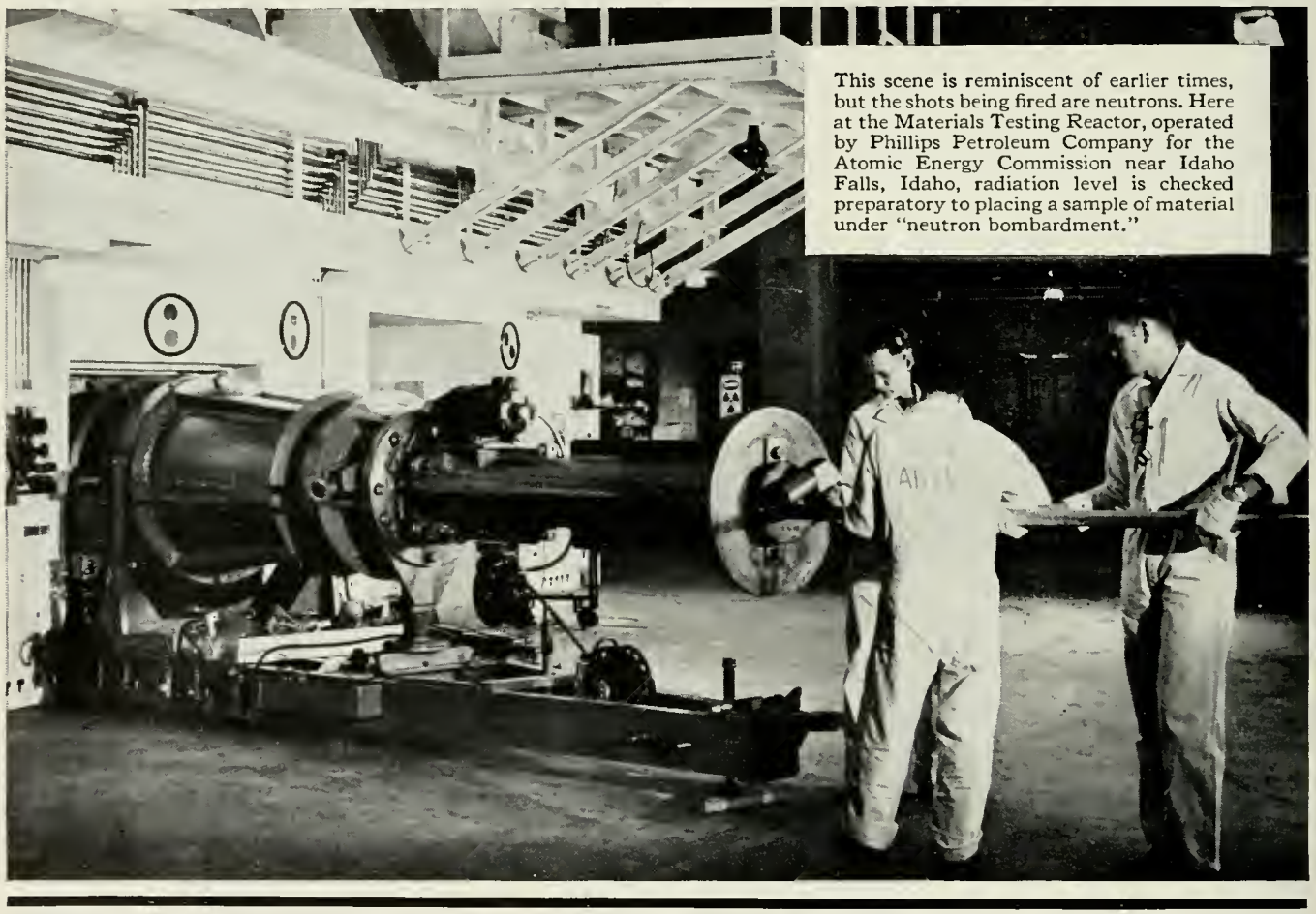


Muzzle Loader—

1955 STYLE



This scene is reminiscent of earlier times, but the shots being fired are neutrons. Here at the Materials Testing Reactor, operated by Phillips Petroleum Company for the Atomic Energy Commission near Idaho Falls, Idaho, radiation level is checked preparatory to placing a sample of material under "neutron bombardment."

Broad assignments in atomic energy represent just one phase of the widely diversified interests of Phillips Petroleum Company.

Whatever your specialty in engineering or the sciences, you may be sure that we are interested in your abilities and your achievements. Already, well over 2,800 technical graduates are found among our 23,000 employees.

Some of these scientists and engineers work to produce and improve our automotive fuels and lubricants. Others develop and manufacture such products as carbon black, synthetic rubbers, chemical fertilizers, sulfur compounds, and chemicals used in synthetic fibers.

If you're looking for a career with a future we invite you to write to our Employee Relations Department for further information about opportunities with Phillips Petroleum Company and its subsidiaries.

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THE ILLINOIS TECHNOGRAPH

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our cover

On the broadwalk between classes in the snow. It's winter even though we haven't hod much snaw. It is a reminder that examinations are near.

our frontispiece

Canvair's new vertical take-off plane. This plane has gone through the transformation between tokeoff and level flight. To go into flight from the takeoff, it just arches into level flight. To land, it stolls ond hangs by its propeller.

NAVY
CONVAIR

FROM PRANDTL TO POGO

by Jim Piechocki, Aero E. '56

The basic theories of aerodynamics, like those of Langley and Prandtl, have stood the test of time. It is only the results of their applications to aircraft design that vary from decade to decade. If they were alive, these two geniuses would be greatly shocked if they were to look upon the aircraft of today and see the results of their studies in the past. And to cushion the shock of their surprise, we would show them the Pogo plane last.

The Pogo? What is it? One way to describe this craft is to say that it is an airplane which sits in the wrong position, points in the wrong direction, and flies in all position and directions. So speak the uninitiated. But those connected with the design and construction will tell you that it is not a plane inspired by the well known pogostick, but one which was born out of need. A few years ago, a group of U. S. Navy officers came up with a startling idea for an airplane which would cut down runway space both on land and on expensive aircraft carriers. Why not build a plane that could take off vertically from a standing position like a helicopter, and upon becoming airborne make a transition to horizontal flight?, they thought. After a few hurried sketches, the officers approached their superiors with the plan. Top naval brass liked the idea and decided to turn the problem over to the engineers. After a great deal of discussion it was decided that the construction of such a plane would be in the best interests of the United States Navy. Lockheed Aircraft Corporation and Convair were granted contracts and work began under a cloak of strict secrecy. This is how the XFY-1 of Convair and the XFV-1 of Lockheed, the world's first vertical-take-off (VTO) planes got their start.

JIM PIECHOCKI

Jim, a junior in his second semester on this compus, has previously written articles for the TECHNOGRAPH while at Navy Pier. He is now busy in organizing an openhouse program for the Aerodynamics depa:tment.

Many new and challenging problems faced the builders of the VTO. This new type represented an entirely new concept of flying from that of the helicopter. Moreover, no precedents had been set in this particular phase of design. What type of powerplant should be used? Engines with the power output required were few and far between. Could any existing engines be adapted to meet the demands the VTO was making? A wing had to be developed which would be efficient in takeoff, transition, and high speed flight. Which airfoil section would provide the best all-around characteristics for this triple demand? Since the plane was to rise vertically, standing it on its tail seemed to be the logical takeoff position. What type of tail would provide maximum structural safety and yet retain desirable aerodynamic characteristics? And how was the craft to be tested? Could such a plane be maintained without difficulty? Could pilots be trained to make the conversion from conventional aircraft? And what about flight techniques? These and other

The Navy's new XFY-1 Convair vertical take-off plane shown in a horizontal position. The special mobile vehicle which holds the plane can be used to raise or lower it.

questions faced Convair and Lockheed engineers.

Let's see how some of these questions were answered. The powerplant is a good starting point. When the Navy Department asked for a high-power, low-weight engine that could be adapted to vertical flight, Allison, a division of General Motors Corporation, accepted a bid. It just happened that Allison, was developing their T40 turboprop engine for installation in the Navy's Convair Tradewind. Due to the engine's extremely high-power-to-weight ratio, Allison proposed adapting the T40 as the powerplant for the VTO. In the summer of 1951, work was begun on a prototype engine for vertical installation. It took some "fancy" engineering too. In order that the oil system would operate in both vertical and horizontal positions, oil pumps, lines, and breathers had to be rearranged. It was necessary to modify the reduction gear, giving a higher propeller RPM and thereby increasing the thrust.

Due to the specially designed propellers to be used counterrotating to eliminate high torque), the control system was redesigned. The large size of the propellers also necessitated a change in the procedures for starting the engine. To evaluate these changes to design, Allison engineers converted a reciprocating engine test stand to accommodate the VTO powerplant in either horizontal or vertical positions, or any position in-between. The test rig consists of a huge 72,000 pound tunnel completely enclosing the engine and propeller. A television camera was installed in the control room so engine operation could be observed in any tunnel position. Engineers in an isolated test cell recorded data from an industrial TV screen. Designated the YTO40-A-14, the turbojet with side-by-side turbines passed the military qualifications test and was accepted by both Convair and Lockheed. The problem of the powerplant was solved.

Let's go on to the problem of choice of a wing for the VTO. A primary consideration in the development of a wing layout that would be effective in transition and horizontal flight attitudes was the airfoil section. Wind tunnel tests provided data leading to the choice of a proper section. The choice of a wing platform was a problem handled in different ways by Lockheed and Convair. Lockheed chose the more conventional straight stubby wing with a relatively small taper ratio (ratio of tip to root chord, where the chord is defined as the distance from wing leading edge to trailing edge). However, Convair picked the delta or triangular configuration. (Convair pioneered the delta wing in this country after the British scored great successes with it. This platform is becoming Convair's standby). Convair felt that the high speed performance characteristics and structural considerations of the delta more than compensated for its relatively poor characteristics at low speed.

The tail configuration did produce some structural complications owing to the fact that the tail surfaces themselves were called upon to support practically all of the weight of the plane. Here is a good example of the case of there being no precedents to follow, as most of the conventional craft in the usual horizontal ground position rarely have such large loads on the tail surfaces. That the problem was solved can be seen from a quick glance at the accompanying photos of Lockheed's ship whose entire weight is supported at four points of the tail surface. Convair's VTO has four over-sized casters (like those on an office chair) mounted at the tips of the delta wing and the tail assembly. Naturally, shock absorbing devices are included. Lockheed's XFV-1 has a similar arrangement, the only difference being that here all of the four casters are mounted in the tail surfaces.

With some of the preliminary design problems solved, engineers speculated as to how the VTO's were to be flight tested. Here again Convair and Lockheed adopted different methods. D. B. Suggs, design specialist of the Convair VTO project, stated the manner in which early testing was accomplished. "We worked out a tethering rig from a scale model of the Moffet Field hangar, some string, a few pulleys, and a weight that represented the plane. "The full scale rig, built into the hangar at the Moffett Naval Air Station from detailed Convair drawings is basically a system of cables strung through various parts of the plane and connected with fixtures which controlled the tension in the cables. Four cables were attached to the wing tips and tail surfaces of the plane while additional cables hooked up the forward part of the fuselage with a large drum located in the roof of the huge 190-foot high airship hangar. A

Lockheed's XFV-1 is shown with the loading platform. The pilot must lie down when the plane is in this position.

special device had to be added to allow clearance of the forward cables with the propellers. The four cables attached to the rear surfaces also were provided with tension-control. As the pilot lifted the ship from the hangar floor, the cables were right there to halt any sudden and uncalled-for maneuver of the craft. As long as the ship's attitude was normal, all drums were in a freewheeling state, thereby providing a minimum of resistance and obstruction to actual performance. If the ship rose or fell suddenly, the cables "caught" the entire weight of the plane until the pilot regained control. As cumbersome as the rig might appear, it allowed a 270-degree freedom-of-turn, and while in the freewheeling state created an actual drag of only 100 pounds. Over 280 "flights" were made in the test rig, mostly in "freewheeling," before the plane was taken out for free flights on August 2. Additional testing included eleven free liftoffs and landings, all vertical, prior to the complete-flight-pattern flight on November 23.

Lockheed attacked the problem of flight testing from a different viewpoint. During preliminary tests, their VTO was equipped with a conventional type landing gear which permitted runway takeoffs and landings. This feature allowed the Navy craft to be thoroughly flight tested, including hovering motionless in the sky like a hummingbird, before making the straight-up takeoff or back-down landing. At this writing the XFV-1 has not yet completed the pattern including the transition from vertical rise to horizontal flight.

Maintenance techniques of both VTO's had to be specially adapted. Just how does one work on an airplane that rests on its tail? Lockheed built a ground handling cart for tilting the plane from vertical to horizontal, thereby facilitating ground work. The cart also is provided with a ladder which enables the pilot to climb and step sideways into the cockpit. Convair's ground cart, although appearing to be somewhat less elaborate, serves the purpose in the same manner as their competitor's.

No man had ever flown a vertical-riser until Convair Engineering Test Pilot J. F. "Skeets" Coleman lifted the new turboprop plane twenty feet into the air and backed it slowly down again on Sunday morning, August 2, 1954. Prior to this historic flight, he underwent an intensive training program to get acquainted with the new and unusual position he found himself in at takeoff. Coleman also spent a great amount of time in the ship while it was in the tethering rig at Moffett Field. Lockheed's XFV-1 has a tilting cockpit seat to keep the pilot semi-upright while the ship is in a vertical position.

Ground handling cart for tilting the plane from vertical to horizontal positions to facilitate ground work.

Flight techniques, to say the least, are quite unconventional. Both VTO's when operating will go through the following maneuvers:

a. Takeoff—a relatively simply procedure. ("When a plane is pointing skyward, resting on its tail, and its engine is producing a thrust force greater than the weight of the plane, there's only one place for it to go—straight up," says one Convair engineer.)

b. Transition to horizontal.

c. Horizontal flight—high power of the VTO's puts them in the above —500 MPH class.

d. Transition to stall — this is the tricky step. The pilot raises the nose of the ship and throttles down until at this high angle of attack he approaches a stall condition, that is, no lift is being developed by the wings. The tail swings down like a pendulum and the plane literally hangs on its propellers.

e. Landing—backing down tail-first to any point desired by the pilot.

Convair's ship has already mastered the complete flight cycle. It made its first transition to horizontal flight on November 2, 1954. Coleman lifted the plane only a few feet off its 50-foot concrete square and arched it smoothly into horizontal flight above Brown Naval Auxiliary Air Station near San Diego, California. The plane was level before it had reached an altitude of 200 feet. After twenty minutes in the air, the plane was brought in at less than fifty feet of altitude and gently nosed upwards until it hung gracefully on its propellers. Coleman then backed it down to a feather-light landing on the same 50-foot square of concrete. The Navy, Convair engineers, and Coleman were equally jubilant, as the latter remarked after the flight, "It's the smoothest plane I ever flew." Meanwhile, Lockheed is

The design engineer trained in welded steel construction is best able to meet industry's need for low cost manufacture because

WELDED DESIGNS CUT COSTS 50%

BY using steel instead of cast iron, design engineers today make their products more efficient . . . *many times at half the cost.* Product designs are stronger, more rigid, take less material to build.

Too little attention is usually devoted to simplification of product designs to eliminate costly manufacturing manhours once a basic design is established. Where designers reappraise product details for welded steel construction, production costs are being cut an average of 50% compared with manufacture using castings.

Manufacturing operations are simplified with welded steel design. Rejections due to inferior metal are eliminated. Less machining and finishing are required. Finished machines are streamlined, more modern in appearance.

In the example below, an economy-minded design engineer lowered manufacturing cost on a machine arm and cut weight of the arm.

Before conversion to steel, the machine arm required 182 pounds of gray iron and cost $38.25 to cast and machine. Welded steel design weighs only 86.8 pounds . . . costs $20.06.

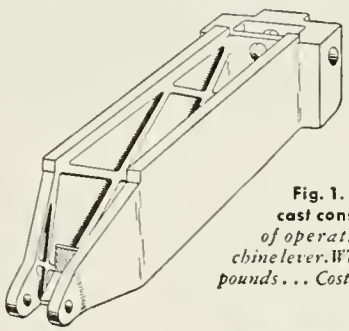


Fig. 1. Original cast construction *of operating machine lever. Weighs 182 pounds . . . Costs $38.25.*

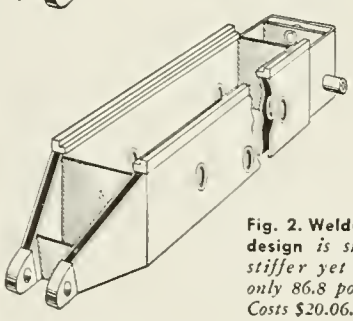


Fig. 2. Welded steel design *is stronger, stiffer yet weighs only 86.8 pounds... Costs $20.06.*

DESIGN DATA *for welded construction is available to engineering students in the form of bulletins and handbooks. Write*

THE LINCOLN ELECTRIC COMPANY
Cleveland 17, Ohio
THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

still working feverishly in an attempt to perfect their design.

What does all this mean? Will the Pogo greatly affect future war tactics? Will naval warships undergo a complete renovation in design? The effect of the Pogo design on military procedures is infinitesimally small at the moment. Evidence: Less than a month ago, the Navy's new super-carrier, the Forrestall, slid her huge 59,600 ton hulk into the waters of the Atlantic. Two Queen Mary ocean liners would fit side-by-side on this giant's deck—and with room to spare. No, the Pogo is not yet very influential, but only the passage of time will tell the whole story of the future of the VTO.

Student Engineers Receive Design Awards

Richard Seikaly of Syracuse, New York, has achieved top honors among engineering undergraduate students by winning the First Grand Award in a national design competition sponsored by The James F. Lincoln Arc Welding Foundation of Cleveland, Ohio. The award, which was accompanied by a check for $1,250, was made for a paper presenting a comparison study of a band saw frame to demonstrate the advantage of welded design over cast iron design. The Foundation also presented Syracuse University, where Seikaly made the study, $1,000 for four annual scholarships honoring Seikaly.

The award was one of 46 made by the Foundation to 62 engineering students representing 25 different engineering colleges. The Foundation sponsors a design competition annually among engineering undergraduates for welded designs of machinery or machine parts and welded structures or structural parts. In addition to the national recognition, the competition offers $5,000 to students and $1,750 to schools in scholarship funds.

Seikaly's paper presented his analysis of the design and manufacturing of a band saw frame both for cast iron and welded steel. The welded steel design proved to be 2½ times lighter and 3½ times less expensive than the cast iron design.

The Second Grand Award of $1,000 was shared by Richard Tannenbaum and Jay Gang, students at New York University. Their school received $500 for scholarships in their honor.

The Third Grand Award of $500 went to David Honnold at the University of Oklahoma which received $250 in his honor.

Papers were judged by a Jury of Award composed of Dr. E. E. Dreese, chairman, Department of Electrical Engineering, Ohio State University; Dean James H. Sams, School of Engineering, Clemson Agricultural College and Professor Sidney Shore, School of Civil Engineering, University of Pennsylvania.

The Foundation is sponsoring the eighth annual competition of the Award Program for 1954-55. All engineering undergraduates are eligible, and the rules may be obtained from The James F. Lincoln Arc Welding Foundation, Cleveland 17, Ohio.

The Convair just after takeoff

TELEPHOTO

. . . *Sends Pictures by Wires*

by Allen Shiner, M. E. '56

Man has been involved in a race to speed the delivery of news between remote points for many centuries, but as recently as fifty years ago no man had dreamed of transmitting pictures by wire, now a common process.

The earliest visual communication undoubtedly was arm waving, which later developed into the semaphore system. When distance became too great for human beings to see each other, they resorted to smoke signals or the reflection of sunlight.

ALLEN SHINER

Allen Shiner is the Chicago editor of the Illinois Technograph. With photography as his hobby, telephotography is right up his alley. Allen plans to come to Urbana next semester to complete his education.

After the invention of photography, however, man began experimenting with the transmission of pictures to distant points. In this process, known as telephotography, pictures are not transmitted bodily from one point to another, but rather are electrically interpreted, sent, and assembled at various points to become exact facsimilies of the original.

An early form of transmission was done by placing a transparent grid over a photograph. In a distant city, an identical grid was placed over a similar, but white sheet of paper. The latter grid had small open squares permitting writings or markings through them. A telephone connection was then set up between the transmitting and receiving points whereupon the operator with the original picture began to convey by voice, an accurate description of the photograph.

Only a trained eye can detect the original from the transmitted copy. This is a transmitted copy of President Eisenhower. (All photos courtesy of International News Photos)

He would start in the upper left-hand square by telling the receiving operator that this square had a tone value of *medium gray*. The receiving operator then would mark in pencil, the described square.

In rapid succession he would relate the succeeding squares *white* or *black* and so on until all the squares had been described.

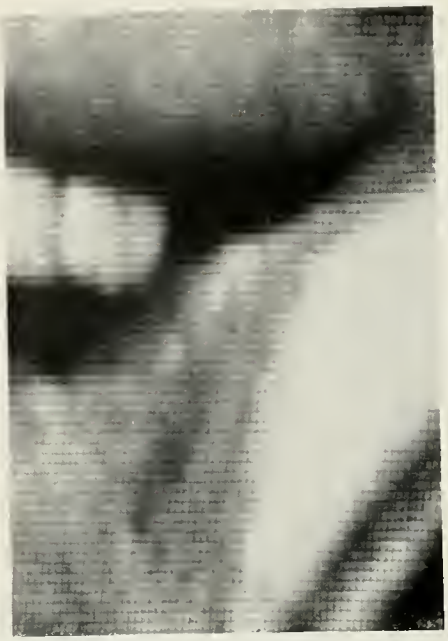
When the intelligence contained in all the squares has been passed along to the receiving point, the operator at this station would lift the grid from the white paper leaving a picture or reasonable facsimile of the original.

Pictures transmitted in this fashion were crude, but with a certain amount of art work, they normally were usable.

Today, electronic and mechanical engineers have developed the same method with automatic equipment, improving it to a point where only the trained eye can detect the original from the transmitted copy.

In this method of transmitting, the photograph is wrapped around a rotating cylinder. A beam of light 1/1000 of an inch square illuminates a spot of the same dimension on the photograph. This pencil of light comes from a lamp and a lens system mounted in a small box which travels from one end of the cylinder to the other parallel to the surface of the picture. By rotation of the cylinder and the slow lateral movement of the pencil of light, the photograph is illuminated progressively in fine spiral lines.

This all important pencil of light is first focused on a light valve which in turn chops the light at a frequency of



The pencil of light is turned on and off rapidly, illuminating a small adjacent square on each line of the photograph. This portion of Eisenhower's face has been blown up 5x to illustrate the above example.

2400-cycles and then passing a pulsating beam which is turned through 90 degrees to focus sharply on the surface of the picture. The cylinder, rotating at 100 rpm, is approximately three inches in diameter, thus giving a scanning area speed of about eight square inches per minute.

This mechanical action is similar to the one where the operator followed the vertical columns of squares down one side of the print and then started from the top of the adjacent column on each line of the photograph. If the pencil of light is turned on and off rapidly, it will illuminate small adjacent squares on each line of the photograph. This action is carried out until all the imaginary squares on the photograph have been illuminated.

Viewing an object is only possible with reflected light. A photo-electric eye is therefore positioning near the cylinder where the pencil of light illuminates the picture. Each impulse of light, depending on the tone values in the photograph, causes a pulse of reflected light to be picked up by the eye. Hence a small white square causes a certain amount of reflected light, while a black square on the picture results in practically no reflection at all.

The photo-electric eye then converts the light values into corresponding amounts of electricity which are transmitted over a specially engineered telephone circuit to the receiving points.

Each square of light results in a pulse of electricity and comes out of the machine at such a great rate, that it sets up a whistle on the phone line. When white is transmitted the whistle is loud. When black is transmitted the whistle is very soft.

At the receiving end of the station, the pictures arrives in the form of an undulating whistle. The electrical impulses are then converted into corresponding light variations, which are in turn exposed on a film or photographic paper.

When power to an electric lamp is increased, the light shines brighter, and reversely if the power is decreased.

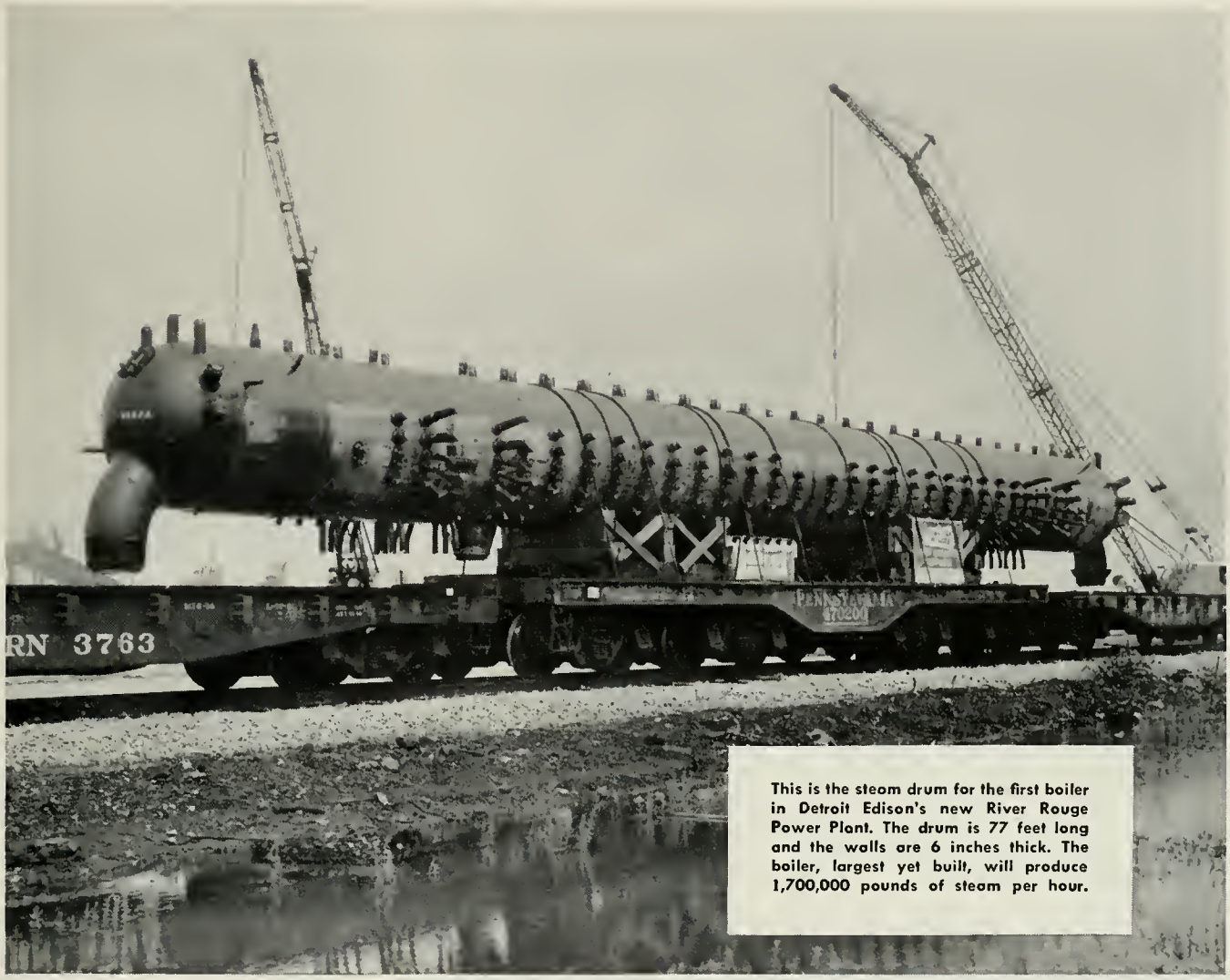
An ordinary filamentary electric lamp cannot respond rapidly enough to the quickly changing electrical signals which are generated in the scanning of the picture. However, the light intensity of certain types of arc lamps can be varied permitting use in these machines. One of these lamps is a gaseous discharge crater lamp, not much bigger than a radio tube.

The incoming electrical signal, built up through the use of an amplifier and varying with the light's intensity can be converted by the crater lamp to create the pencil of light, thus making possible the production of positive prints or negative films.

Positive prints are made by igniting the crater lamp to full brilliancy with local power. The incoming, amplified signal is then used to buck the local power going into the crater lamp. A loud signal (white) with lots of power causes the lamp to almost extinguish and a soft signal (black) with no power lets the lamp expose the paper to full black.

A negative film is made by barely

International's latest model transmitter and receiver, the 700 series.



This is the steam drum for the first boiler in Detroit Edison's new River Rouge Power Plant. The drum is 77 feet long and the walls are 6 inches thick. The boiler, largest yet built, will produce 1,700,000 pounds of steam per hour.

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Today, Detroit Edison is installing the world's largest boiler.
Soon the company will install the world's largest steam turbine-generator.
In the last ten years Edison has doubled its capacity to produce electricity—but it's not stopping there.
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Can this be your bright future? See our representative when he's on campus. Stop in at our office, or write . . .

THE DETROIT EDISON COMPANY

2000 Second Avenue, Detroit 26, Michigan

igniting the crater lamp with local power and letting the amplified picture signal build up its brilliancy, so that the loud white signal causes a maximum exposure in the film. The paper or the film is wrapped around a receiving cylinder similar to the one being used at the transmitting station and the pencil of light travels slowly from one side to the other, as described above. Standard photographic processing technique is then applied to the paper or the film.

A tuning fork is employed to maintain synchronization between the sending and receiving cylinders. The fork is a small, highly accurate generator of sound or vibrations. These mechanical vibrations can be converted into electricity with the help of an electromagnet. The electricity, in turn, is amplified to derive sufficient power to run the motors which drive the rotating cylinder and the moving scanning box.

The above system can only be used on the continent. Pictures are sent from Europe to N.Y. or from Asia to San Francisco by means of radio waves.

The pictures then are put on telephoto machines and transmitted to all points by the former process. News pictures from North American news sources are likewise transmitted to New York and radioed abroad.

New York serves as the nerve center of the telephoto operation. From there, pictures are scheduled for the entire world.

By using the same phone wires as used for transmission, each picture is described briefly, and in a matter of minutes New York is informed as to which pictures are available. The desk then compares these descriptions, and in a matter of moments the main network stations are receiving on-the-spot news.

In addition to copy of general appeal, there are many pictures of purely sectional, regional interest. At certain network stations, the wire can be "split" making possible the transmission of a number of regional pictures in different areas of the country.

Rarely does a day pass but that a portable unit contributes to page-one picture news. A man is sent with a machine to some normally uneventful scene to transmit to the network from there.

Within fifteen minutes of President Truman's appearance on the platform of the 1948 Democratic National Convention, the exposed film had been returned for processing, which even through the fastest possible procedure takes thirty minutes, a picture was on the wire. When a Russian schoolteacher climaxed one of many news stories of 1948, by jumping from a window of the Soviet consulate, photos taken at the scene were being transmitted in less than thirty minutes.

Telephoto is commonly compared to a delayed television transmission. The final result is slightly different also in that it is viewed as a photograph rather than a screen. But the technical methods, however, are alike. The advent of the coaxial cable has permitted the transmission of many more picture impulses per given time unit over ordinary telephone wires. The future looks very bright. The cost will be considerably higher, but because of its high frequency range, it offers real possibilities in the transmission of color.

This picture was transmitted and received in a matter of minutes. The transmitting point, Rome. The receiving points, New York and all points west.

Teacher: "How do you suppose Noah spent his time in the ark?"

There being no response from the class, she added, "I suppose he did a lot of fishing."

"Fine chance," jeered little Freddie. "With only two worms."

* * *

Nothing can give you that rundown feeling like jaywalking.

* * *

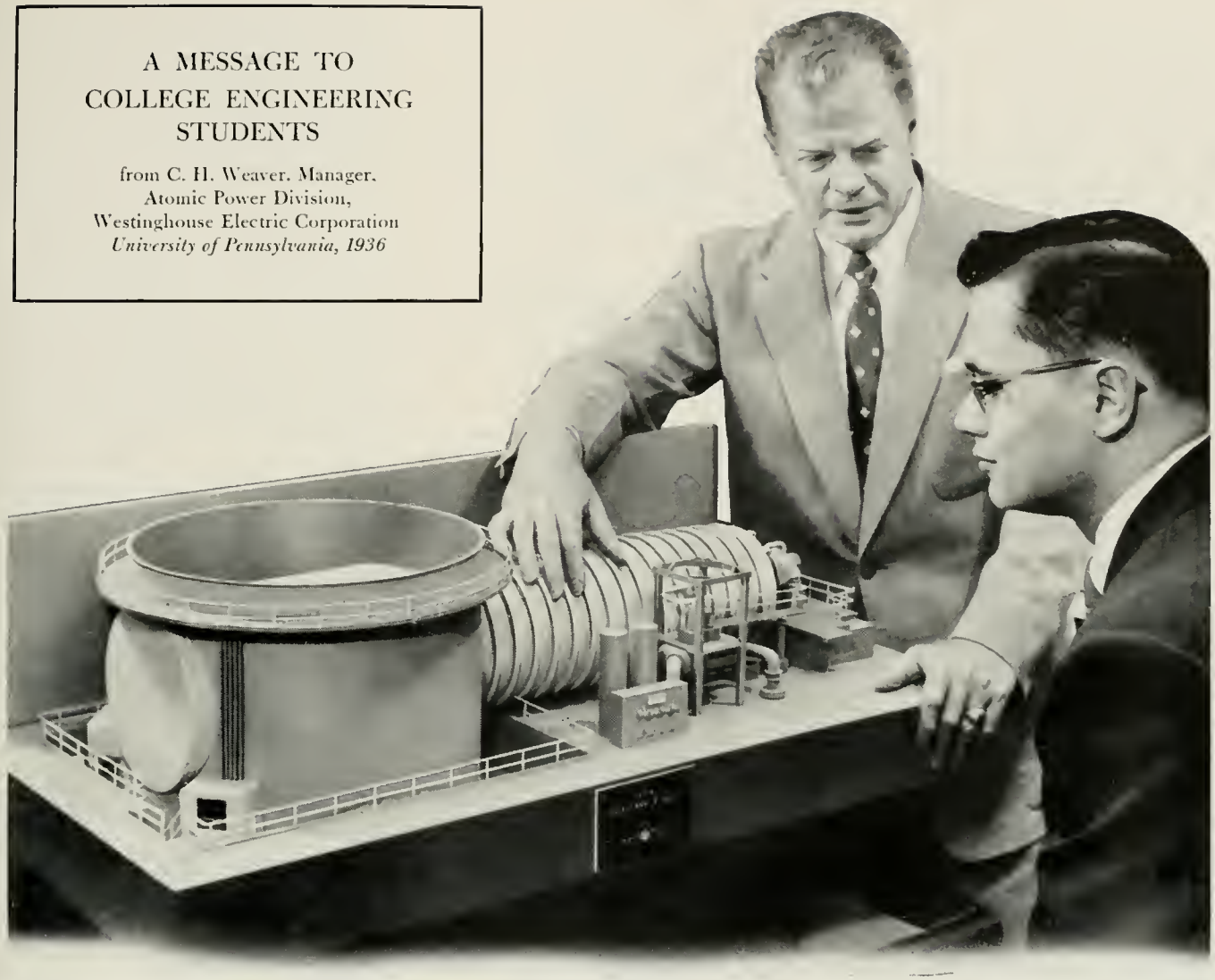
A girl finished with her bath and was just stepping on the scales to weigh herself. Her husband returned home unexpectedly and entered through the back door. Seeing what his wife was doing as he passed the bathroom door, he exclaimed, "Well, dear, how many pounds today?" Without turning her head, she replied, "I'll take 75 pounds today, and don't you dare pinch me with those tongs."

* * *

A drunk in the Empire State Building stepped into an elevator shaft and dropped thirty stories to the basement. When he landed, he shook his fist and remarked, I shaid up, not down."

A MESSAGE TO
COLLEGE ENGINEERING
STUDENTS

from C. H. Weaver, Manager,
Atomic Power Division,
Westinghouse Electric Corporation
University of Pennsylvania, 1936



To you who want to help create the atomic age

You're looking at the practical beginning of an atomic age.

This is a model of the land-based prototype for the first atomic submarine engine, designed and built by Westinghouse—working with the Atomic Energy Commission and the U. S. Navy.

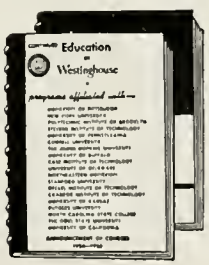
And now, Westinghouse is developing the world's first atomic power plant to harness this vast power for peacetime use. Its output, enough for a city of 100,000 people, will go into a utility's power system.

Since 1948, Westinghouse has had an Atomic Power Division for atomic energy development . . . and it now has an Atomic Equipment Department to develop apparatus for atomic power installations. These are typical of the steps our forward-looking Westinghouse management is constantly taking in leading the way toward development of new sources of energy and new products.

Wouldn't you like to be with Westinghouse . . . helping to create this new era?

We at Westinghouse are interested in you as an *individual* . . . interested in your ambitions as well as your technical ability. For your professional development, there is a Graduate Study Program, available in 19 universities, and leading to your Master's and Ph.D. degrees. And there are other Westinghouse programs to fit your individual needs . . . all aimed at helping you reach your goal. G-10281

YOU CAN BE **SURE**...IF IT'S
Westinghouse



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Expensive but Strong

TITANIUM

by Harvey Endler, E. Phy. '56

Just as at the turn of the century aluminum was being proclaimed the "wonder metal" of the age, so today's "wonder metal" is titanium. Although titanium has been known for many years, its somewhat extraordinary properties have just recently caused it to come into great industrial and military demand. The four qualities which cause it to be so greatly suited for the complex and

HARVEY ENDLER

Harvey is a junior in Engineering Physics. He sent articles to the Technograph while he was a student at Navy Pier. We are hoping to have many more fine articles from this Chicago lad.

fast moving devices of today are lightness, strength, corrosion resistence, and high ductility. Titanium is almost three times as strong as aluminum, although it has only twice the density; it is five times as strong as the magnesium alloys; it has half the weight of steel, but is as strong as many of the steel alloys; in salt water it resist corrosion better than aluminum, stainless steel, chromium, magnesium and all other metals and alloys of general engineering significance; up to 800 degrees F titanium alloys have greater strength for their weight than any common metal or alloy.

Titanium, a silver-white metal stands in group IV A of the periodic table, along with the elements zirconium, hafnium, and thorium. These elements, in general, tend to form compounds in which their oxidation state is plus four, although being among the so-called transition elements, other oxidation states are frequently encountered. A few of the physical constants of titanium are:

atomic number, 22
atomic weight, 47.9
density, 4.5 gm/cc
melting point, 1812° C
boiling point, 3130° C

At normal room temperature, the type of crystal lattice is hexagonal close packed, known as the alpha modification, but at about 1625° F it changes to a body centered cubic, the beta modification. Titanium is the eighth most abundant metal in nature and the fourth most abundant metallic element, being four times more plentiful in the earth's crust than manganese, chromium, nickel, copper, zinc, cobalt, lead, tin, gold, and silver combined. It is the next most common metal after iron, and its percentage in the earth's crust has been estimated at .43. The principal sources of titanium are the dioxide, which occurs in two crystal forms, tetragonal (in rutile and anatase) and rhombic (brookite), ilmenite ($FeTiO_3$), and numerous titanosilicates. The largest domestic source of titanium is the ilmenite deposits in New York State, and the sands of certain beachs in India, Australia, and Brazil are the principal foreign sources.

Although titanium is first coming into widespread use, it has been known for over one hundred and sixty years: in 1789, William Gregor, a Cornish clergyman found that the sandy-black iron ore (ilmenite) from Menachan, Cornwall, was the oxide of a new element, which he appropriately named *menachanite*. In 1775 an Austrian chemist named Martin Heinrich Klaproth found an unfamiliar element in rutile and suggested that it be named *titanium* in allusion to the great strength of the Titans of Greek mythology. Klaproth later proved that *menachanite* and *titanium* were the same element and from 1797 on only the latter name was used. Although Rose successfully purified the dioxide in 1821, attempts to isolate the pure metallic element itself were unsuccessful. In 1825, the year in which aluminum is believed to have been isolated, the famous Swedish chemist Berzelius was able to isolate a very low purity sample of titanium metal. By 1887 a 95% purity had been obtained by the reduction of titanium tethachloride with sodium and in 1895 Moissan was able to produce a 98% purity by the reduction of the tetrachloride in an electric arc. In 1912, Mathew A. Hunter of Rennsselaer Polytechnic Institute was able to produce titanium pellets of 99.5% purity by the old tetrachloride-sodium reaction, however the metal produced by this method was ductile only when hot, and brittle in the cold state. It was first recognized by Arkel, de Boer, and Fast that titanium is quite ductile even when cold. They used a new method of extraction which consisted of dissociating titanium tetraiodide on a hot filament. This discovery whetted interest in the new metal because of the attractive ductile properties disclosed, but the process was so costly and technologically difficult that it was prohibitive to commercial application.

The reason for this slow development of purifying processes and also for the fact that commercially pure titanium (99.5%) sells for the exceedingly high price of from five anywhere to fifteen dollars a pound lies in one annoying property of the metal—its great affinity for absorbing gases. When the metal is molten, or for that matter even hot, it combines readily with almost anything that it touches. This would not be so bad except for another quality of the "wonder metal" which further complicates matters; titanium is so extremely sensitive to oxygen, nitrogen, and carbon that if as much as a few tenths of a per cent of any of these should be absorbed the properties are drastically altered and the metal often becomes highly brittle. Thus the main problem was finding a process in which there were no refractories from which the molten titanium could eat up the oxygen or no crucibles from which it could become contaminated by the absorption of mere traces of carbon.

From the industrial standpoint, the greatest milestone in the development of titanium resulted from the research of Wilhelm J. Kroll, a Luxembourg metallurgist who was working as consultant for the Bureau of Mines. In 1940 he announced a reduction technique which produces a quality grade of the ductile metal on a commercial scale and at a reasonable cost. The Kroll method consists basically of reducing

high purity titanium tetrachloride with magnesium, and is currently being used by the Henderson, Nevada plant of the Titanium Metals Corporation of America (TMCA) among others. Rutile is used as a plant feed rather than ilmenite because of the difficulties involved in separating iron chlorides produced during the formation of the tetrachloride. After the use of conventional separating procedures, the rutile used as plant feed is about 95% titanium dioxide. Ilmenite, containing only between forty and sixty per cent titanium dioxide, is much more plentiful domestically, being obtained from very large deposits in New York State, and therefore would be preferred over the imported rutile if some efficient method of removing the iron chlorides could be found.

The Kroll process as it is performed industrially today begins with the blending of the rutile with ground coke. This mass is fed into a moving kiln where the volatiles are burned off, leaving a porous hard mass which is broken into fragments to form briquettes. The briquettes go to a chlorinator which is maintained at a temperature of 800 degrees C or higher, in which chlorine gas is passed upward through them. The principal reaction of this process can be given as

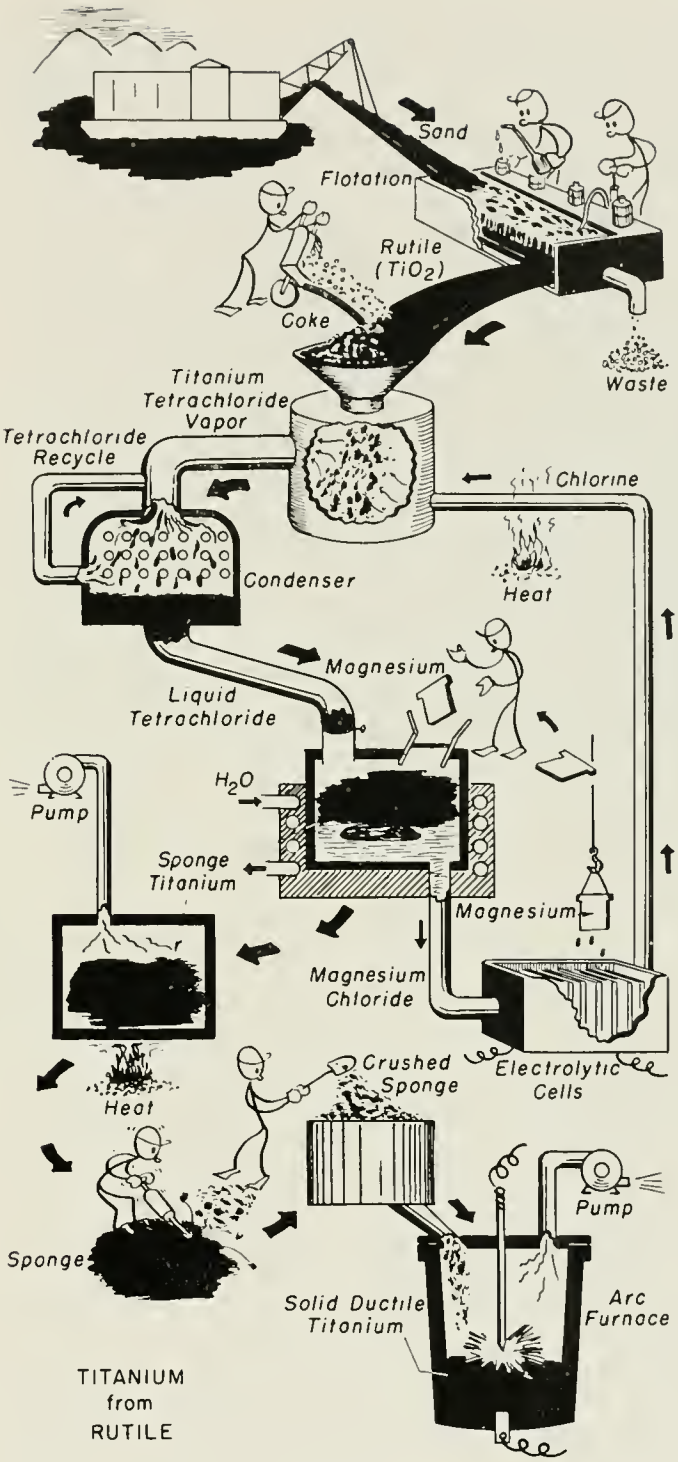
$$TiO_2 + 2Cl_2 \rightarrow TiCl_4 + O_2$$

although some carbon monoxide, carbon dioxide, and excess chlorine are also evolved. These product gases pass through dust collectors and the $TiCl_4$ condensing towers. Condensed $TiCl_4$ is pumped to a settling tank where insoluble matter is removed, and it is then ready for reduction.

The titanium tetrachloride is fed onto molten magnesium in a closed vessel, the reaction temperature being about 850 degrees C. The interior of the retort is either exacuated or filled with some inert gas under pressure, usually helium, to prevent any undesirable reactions. An excess of magnesium is provided, and during the reaction titanium metal and magnesium chloride are formed. This reaction is given as

$$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2.$$

After the reaction is complete, the retort is immediately cooled. Either a special horizontal boring mill or a lathe is used to remove the solid product from the reactor, and it is cut into small chips during the removal. All of the boring operations are carried out in a dry atmosphere to prevent hydrolization of the magnesium chloride. The chips are slowly fed into a dilute HCl solution which dissolves the remaining magnesium chloride but does not appreciably affect the titanium metal. $MgCl_2$ in solution is drained from the crucible, and by means of electrolysis magnesium and chlorine can be obtained from it for reuse in the appropriate steps of the process. The titanium chips are again leached and then are in the form known as titanium sponge—hard, grey, porus lumps which have the consistency of coke but however are unusable until they are melted down into ingots and then fabricated.



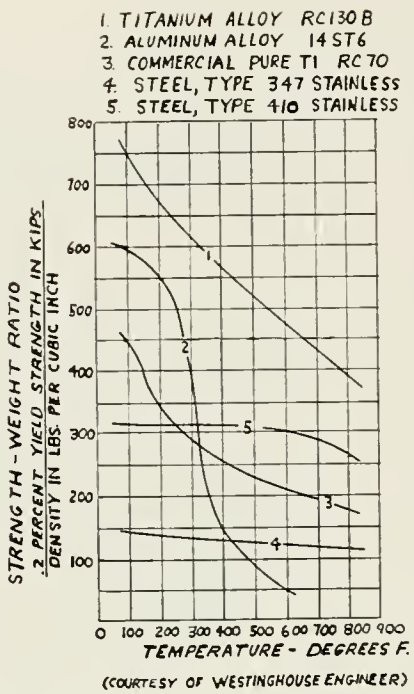
The Processing of Titanium

Batches of titanium chips are consolidated into ingots in large arc furnaces. These batches are analyzed before being fed to the furnaces, and they may be separated according to the purpose for which the finished metal is intended, or according to which alloying elements are to be used. At the Henderson plant of TMCA the melting furnaces are of a special design in which the sponge is melted from the electrode into water cooled crucibles. Water cooling of the walls of the crucible is highly effective, because the molten titanium freezes around the edges to form a skin of itself,

and the picking up of any contaminating carbon is minimized. Although at first obstacles to the production of large size ingots seemed insurmountable, ingots of up to a ton in weight are now easily produced. The resulting ingots are turned to remove surface imperfections and they are then ready for conversion to bar, die forgings, wire, tubing, flat rolled products, or to whatever use the Ti is to be put.

In addition to TMCA which produces about 3,600 tons of titanium a year, the Kroll process described above is in present use by E. I. Du Pont and will be used in the future in plants now under construction by the Cramet Co. in Chattanooga, Tennessee and Horizons Titanium Inc. of Cleveland. Other large titanium producers in this country are the Crane Co. of Chicago, the Metal Hydrides Co. of Beverly, California, and Rem-Cru Titanium Inc. of Midland, Pa. Also, the Electro-Metallurgical Corp. is in the final planning stages of a plant which will produce 8,000 tons a year by a process based on sodium reduction, one of the pioneering extra-active procedures in the development of titanium. Although the government and industry seek to boost titanium production in this country to 35,000 tons a year by 1957, it is estimated that the production capacity will be only about 15,000 tons by 1956. This is a tremendous figure considering that only 75 tons of titanium were produced in the U. S. in 1950.

Once titanium has been produced in ingot form, operations such as rolling, drawing, and forging may be executed with essentially standard techniques. Machining operations, however, such as drilling, spot-facing, counterboring, and tapping presented some new problems which had not been encountered with most other metals. Although titanium alloys are not excessively hard, abrasive particles of titanium carbide frequently found in them cause very rapid wearing of the tools. Also a contributing factor in tool wear is the smearing tendency common to all titanium alloys which causes extreme abrasion of the tool edge. New machining techniques and new methods of reducing the carbon content of titanium alloys have now been found such that it now costs no more to machine them than it does stainless steels. These techniques include the use of super-hard grades of carbide and high-cobalt edges for cutting operations, and the use of carbon dioxide gas as a coolant rather than the conventional liquid oils or emulsions. By directing narrow streams of carbon dioxide directly at the tool-work interface, tool breakdown is reduced because of the elimination of overheating and also because of the reduction of the attrition of the titanium. Because of the economic reasons for



Titonium is much stronger per pound than any other metal, especially at high temperatures.

reclaiming as much of the scrap as possible, carbon dioxide has another great advantage; films and oxides left on titanium by ordinary coolants must be removed before the titanium can be remelted (because of embrittlement) whereas chips produced during the machining with carbon dioxide are clean and bright and an excellent material for remelting.

Forging of titanium and its alloys is accomplished quite readily by conventional procedures, and these materials flow easily, readily fill the dies, and give good sharp impressions. On a weight basis, about 30% more force is required than would be required for steel, and it has been found that better results are obtained with dies that are more massive than those used for steel. An upper limit of temperature is necessary in forging because the rate of penetration of oxygen and nitrogen into the metal becomes very rapid at higher temperatures and the resulting scaling and surface hardening can become a serious problem. Grinding is a somewhat more difficult problem because of the extremely high rate of wear of the grinding wheel. Aluminum oxide and silicon carbide wheels have been found best for the purpose. Wet grinding is usually employed, both to minimize the chance of an explosion of the titanium dust and to prevent thermal cracking which can result from the localized overheating caused by the very low thermal conductivity of titanium. The welding and joining properties of titanium alloys have been investigated carefully by the aircraft industry, and although it has been found that these alloys can easily be welded to themselves by inert-gas-shielded arc methods, the procedures for joining thse materials to other constructional metals are still in the development stage.

Titanium's greatest future lies in its alloys. The commercially pure titanium being sold at present is in fact an alloy containing about 99.5% titanium. It can be alloyed with iron, oxygen, chromium, magnesium, manganese, aluminum, molybdenum, and tungsten. Alloying elements are used for stabilizing the high temperature beta modification, for producing alloys which are hardened by heat treatment, and for strengthening the low temperature alpha modification. An alloy produced by the Rem-Cru Co. and designated as RC-130A contains the largest percentage of a single alloying element—7% manganese; this particular alloy also contains a maximum of .2% carbon, and traces of oxygen, nitrogen, and iron. Ti-150 B, produced by TMCA contains the largest total percentage of alloying elements—5% each of chromium, iron, and molybdenum, .02% of carbon and tungsten, and a trace of oxygen. Although a great many alloy combinations have been investigated in the laboratory, only a few are available commercially at present, each manufacturer listing his own alloys by composition.

There are many promising uses for titanium in jet and gas turbine engines for aircraft. It has withstood tests in firewalls, shrouds, baffles, complete compressor sections, afterburners and diaphragms, where its big advantage over aluminum is great strength in the 500 degree F range, and its advantage over stainless steel is in weight saving. Whereas the tensile strength of aluminum falls off sharply beyond 300 deg F, titanium alloys have good tensile strength up to about 800 deg F. A .015 inch thick sheet of stainless steel weighs .60 lbs sq. in. whereas a titanium sheet of the same thickness weighs only .35 lbs. sq. in. Using titanium instead of stainless steel might lighten a jet engine by three hundred pounds, which is equivalent to about fifty gallons of fuel. It can also be used in aircraft landing gear, propellors, armor, skin, and internal construction. Titanium is also being used in various components of rockets and guided missiles.

Titanium's resistance to salt water makes it extremely useful in marine equipment. It can stand the wear which brine has been known to inflict upon even stainless steel. A few parts in which the Navy would like to make use of titanium are: snorkel tubes for submarines, valve seats, heat exchanges, condenser piping systems, pump shafts,

Bill Zartman wants to know:

What effect would an advanced degree have on my opportunities for advancement at Du Pont?

William N. Zartman is studying for a B.S. in Chemical Engineering at the University of Illinois. Last summer he worked in the Technical Laboratory at Du Pont's Chambers Works to gain industrial experience. He has not yet selected a permanent employer, however; and right now he's asking the kind of questions which will help him select the right job and plan a successful career.

Dr. Sheldon Isakoff received his Ph.D. degree in Chemical Engineering from Columbia University in 1952, doing his graduate research work on the problem of heat transfer in liquid metals. Since graduation he's been engaged in fundamental research work at the Du Pont Experimental Station, Wilmington, Delaware. Dr. Isakoff is now a Research Project Engineer in the Engineering Research Laboratory.

Sheldon Isakoff answers:

An advanced degree would undoubtedly have a *favorable* effect in technical work, Bill, but let me enlarge on that just a little. In my own field—chemical engineering—a doctorate is considered to be evidence of demonstrated ability in carrying out original research. An advanced technical degree is therefore helpful in obtaining work in research and development, where that skill is definitely important. You might say it gives a man a head start in proving his ability in those areas.

It's less important in some other areas, though. For example, in production or sales work a manifest ability for handling human relationships is just as important for advancement as technical competence. If an engineer is sold on production work or sales, a graduate degree in marketing or business administration might be more helpful to him than advanced technical training—in getting started.

But I've noticed this at Du Pont. Once a man lands a job in his chosen field and actually begins to work, his subsequent advancement depends more on demonstrated ability than on college degrees. That's true throughout the entire company—in scientific work, administration, or what not.

So an advanced degree is not a royal road to anything at Du Pont, Bill. But when coupled with proved abilities, an advanced technical degree is unquestionably helpful to a man in research and development work. It often gives him a chance to demonstrate his abilities more rapidly.

Are you interested in research work?

About 2000 Du Pont scientists are currently engaged in research, aided by some 3500 other employees. Laboratory facilities of the highest quality are available at the Du Pont Experimental Station near Wilmington, and elsewhere throughout the country. Full information about research work at Du Pont is given in "The Story of Research." Write for your copy of this free 28-page booklet to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Building, Wilmington, Delaware.

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SCIENTIFIC AND ENGINEERING STAFF

Culver City, Los Angeles County, California

Photograph above: Engineer-writer John Burnett (left) works with engineers John H. Haughawout (right) and Donald King to compile handbook information.

small propellors and propellor shafts, and steam turbine blades. There also is great optimism about titanium's use in the ordnance field, particularly in airborne and mobile types of guns where the lighter the metal is, the better.

Industrial use will be curtailed until the high price drops markedly. Portable machine tools, fast moving spindles, spools, warp beams and other moving parts of textile machinery are representative of the many places in industry where a strong but light material is advantageous. It may also find use in sporting equipment such as golf clubs and fishing tackle, and miscellaneous pieces such as orthopedic braces. The ability of titanium, when hot, to absorb large quantities of oxygen, nitrogen, and hydrogen—a direct nuisance in the refining of titanium—is put to good use in electron tubes. Titanium is used to absorb these gases as they are boiled out of the glass and other tube parts.

Instructor: "Before we start this final exam, are there any questions?"

ME: "What's the name of this course?"

* * *

"Faith," declared Mike, " 'tis an unthankful country that is, now. Here we Irish have done so much for the United States and b'jabbers they've named only state after an Irishman!"

His faithful friend Pat raised his red eyebrows. "I didn't know there was such a state, Mike!"

"Sure and have ye niver heard o' that western state, O'Regon?'

* * *

Indian Chief Lotta Bull had 10 wives and the government agent had just found out about it.

"Bull," he said firmly, "We must all obey the laws. Now you go straight home and tell all those wives but one that they must go!"

The chief reflected a bit. "You tell 'em," he said.

* * *

Two stewdents were discussing life in one of the local taverns. One said, "Y'know, when I was born, I only weighed two poundsh."

"No kidding. Did you live?"

"Did I live? Shay, you ought to see me now."

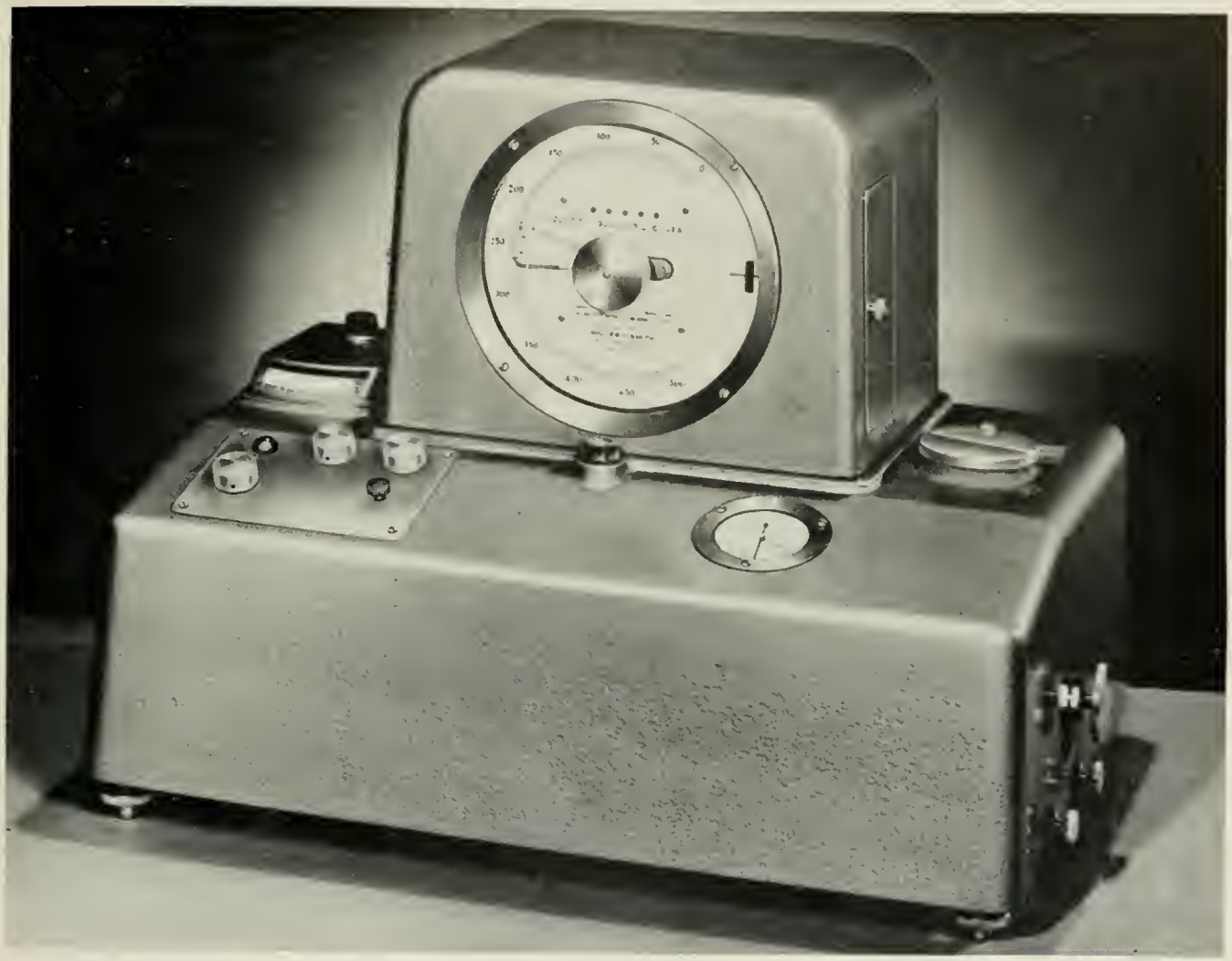
* * *

The meek little gent in the restaurant finally sighed and decided to give up his steak. Je was tougher than sole leather. He called the waiter and pleaded that it be taken back to the kitchen. The waiter dolefully shook his head and said, "Sorry, pal, I can't take it back now. You've bent it."

* * *

Professor: "Give the most important fact about nitrates."

Student: "They are cheaper than the day rates."



THE PERCENTAGE of hydrogen in liquid hydrocarbons can be determined by making two simultaneous measurements on the sample to give (1) density and (2) the absorption rate for beta rays. The weight percentage of hydrogen in the sample is computed from these measurements and a calibration curve. The new instrument shown here, a Standard Oil development, measures the beta ray absorption rate.

BETA RAY

used to speed hydrogen measurement

The problem: How to measure the percentage of hydrogen in organic compounds in a short time.

The established process was combustion. It took about four hours, and so discouraged the use of hydrogen determinations. But such analyses are increasingly important. Processes in the petroleum and chemical industries often involve hydrogenation or dehydrogenation. In addition, the percentage of hydrogen is an index to the performance of critical fuels such as those used in jet planes.

A rapid method for measuring hydrogen content would therefore be a great help in both research work and plant control. Standard Oil's Engineering Research Department, specialists in solving technical problems, took on this challenging assignment.

A new machine—a beta ray hydrogen analyzer—was invented and constructed. It gives results in five minutes, and is twice as accurate as the old combustion method. It is so easy to operate that a laboratory technician can use it.

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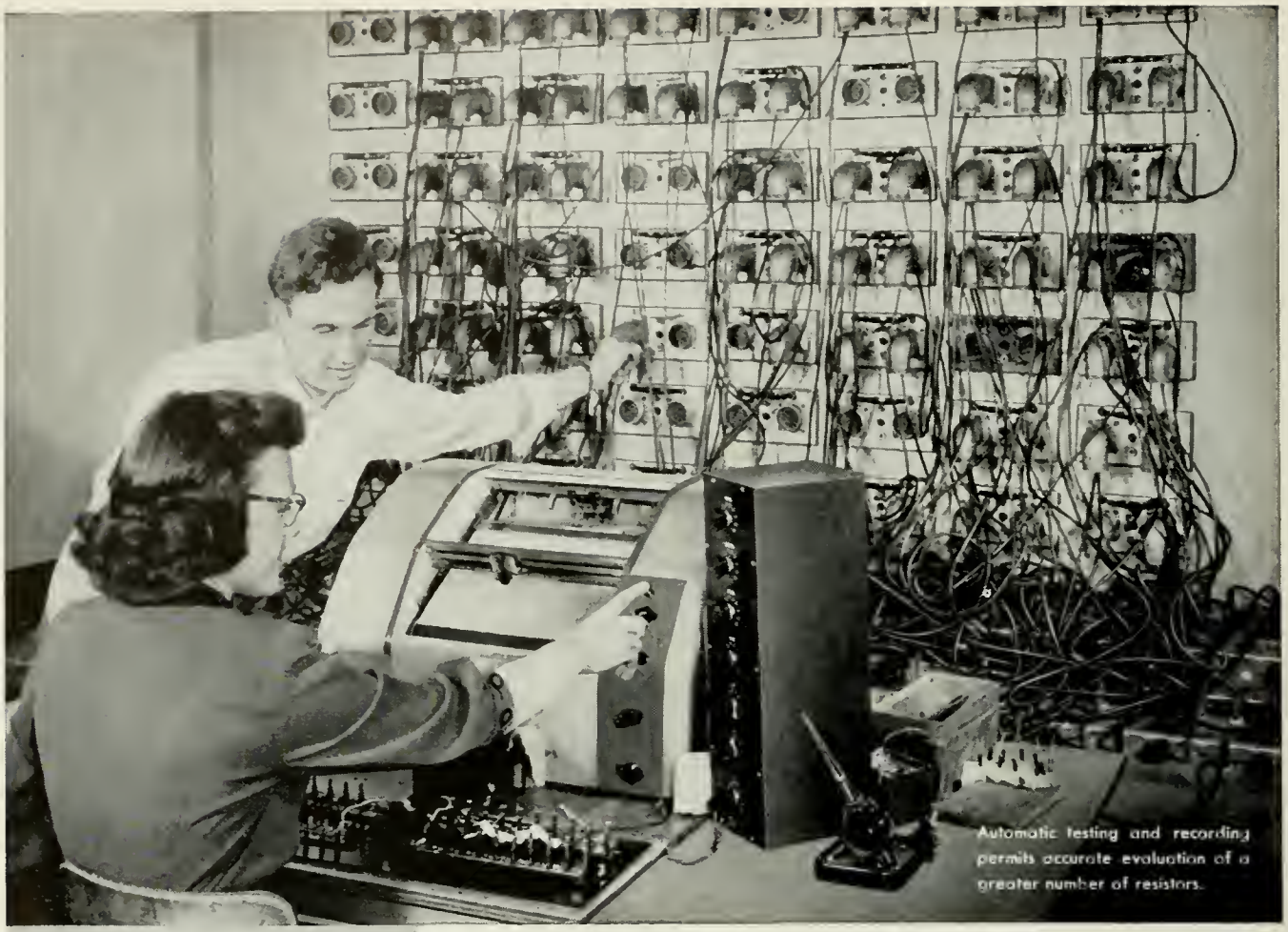

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IRC Power Wire Wound Resistors
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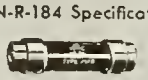
Type BW Low Wattage Wire Wounds
JAN-R-184 Specification



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The Sanitary Engineering Department

by Kieth Yarborough, Civ. E. '55

Since the beginning of history, man has been confronted with the problem of waste disposal. The earliest records of his action on such problems date back to the thirty-seventh century B. C. In India during this time, sewers were being constructed to handle sewage flows. Other findings by archeological expeditions indicate the existence of many such drainage systems which served the civilization centers of the near East and Romance countries during the pre-Christian period.

However, our predecessors seemed satisfied solely with the collection of sewage and its subsequent most convenient disposal; presumably by dilution in bodies of water or by absorption into the earth. Thus, it was not until comparatively recent times that adequate consideration has been given to the problems of sewage *treatment*. Nevertheless, from the beginnings made in the middle nineteenth century, tremendous advances have been achieved, especially in the last fifty years. Workers at the University of Illinois, as at other experiment stations throughout the world, have been active in helping to achieve this progress. However, of great significance in any such work are the facilities for carrying on the proposed projects and research. No ideas, no matter how promising, can be thoroughly studied without adequate equipment and convenient working space.

However, up to 1942, experiments were still being performed in the old Sewage Research Laboratory under adversities which made the ease of testing and exactness of control much more difficult. Despite these drawbacks, the contributions resulting from information obtained in this lab were many and of importance to the science of waste disposal and treatment.

Finally, in 1942, the "temporary" structure, located near the Boneyard Creek, which housed the old laboratory became untenable because its condition had made it impossible for the Physical Plant to maintain properly. As we all vividly recall, this was a period of desperate need for well-trained technical personnel, among them sanitary engineers. To facilitate the training of such men to aid in the war effort, funds were appropriated by the University from existing sources which at that time were especially adequate. Because of the urgency of the times, priorities for the necessary materials were readily obtained, construction carried out and teaching and research soon resumed in the new surroundings.

University of Illinois Sonitory Engineering Laboratory. Built in 1942, it provides facilities for teaching and research serving the stote ond effecting the entire nation.

The efforts of Professor H. E. Babbitt, for many years head of sanitary research at the University of Illinois, and Professor W. C. Huntington, head of the University of Illinois Department of Civil Engineering, were instrumental in obtaining authorization, funds, and eventual construction of the present lab. Completion of this project made possible the realization of a long sought goal for Professor Babbitt.

Today this modern, three-story, brick building provides a place conducive to the pursuit of research on the treatment of water and sewage. Its five thousand square feet of floor area which was designed for greatest flexibility in use give ample space for laboratories, classrooms, offices and a well-equipped machine shop. These facilities and the mechanical equipment enable one to carry on studies of not only the various methods of sewage and water treatment, but also biological, bacteriological, and radiological examinations to measure the effectiveness of such methods. There is

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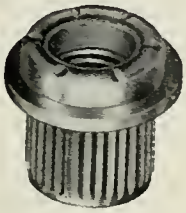

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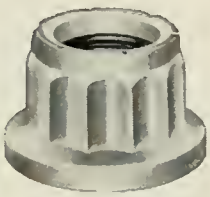

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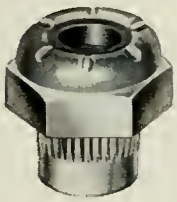

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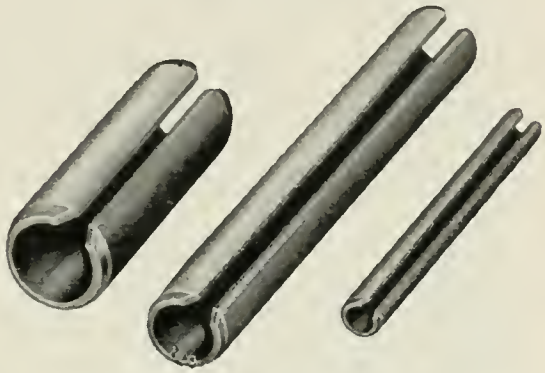
Rollpins



dia. from 1/16" to 1/2"

Rollpins are slotted, tubular steel, pressed-fit pins with chamfered ends. They drive easily into holes drilled to normal tolerances, compressing as driven. Extra assembly steps like hole reaming or peening are eliminated. Rollpins *lock* in place, yet are readily removed with a punch and may be reused.

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- ☐ Here is a drawing of our product. What fastener would you suggest?

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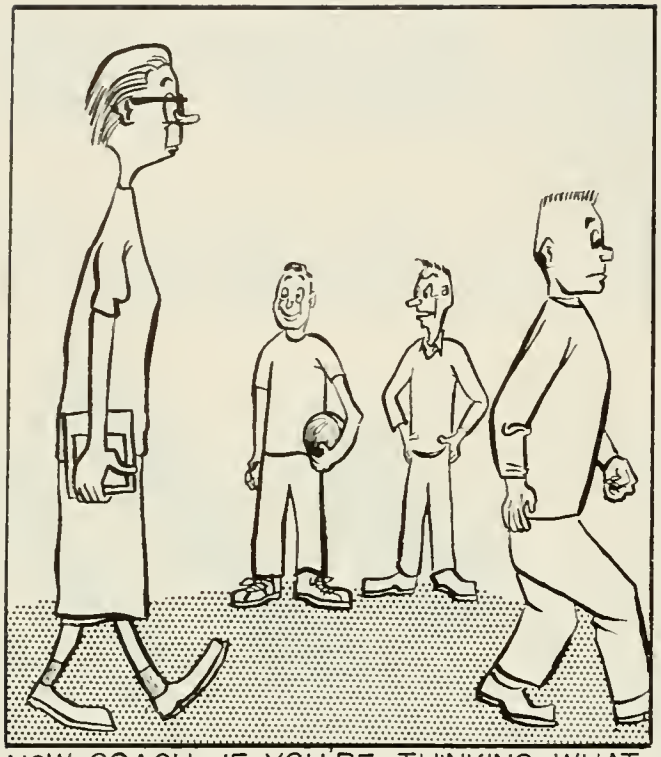
CRENSHAW



NOW COACH, IF YOU'RE THINKING WHAT I THINK YOU'RE THINKING, THEN STOP THINKING IT!

NOW SEE HERE, CRENSHAW, WHEN ONE GETS PINNED, IT DOESN'T MEAN AGAINST THE WALL!!

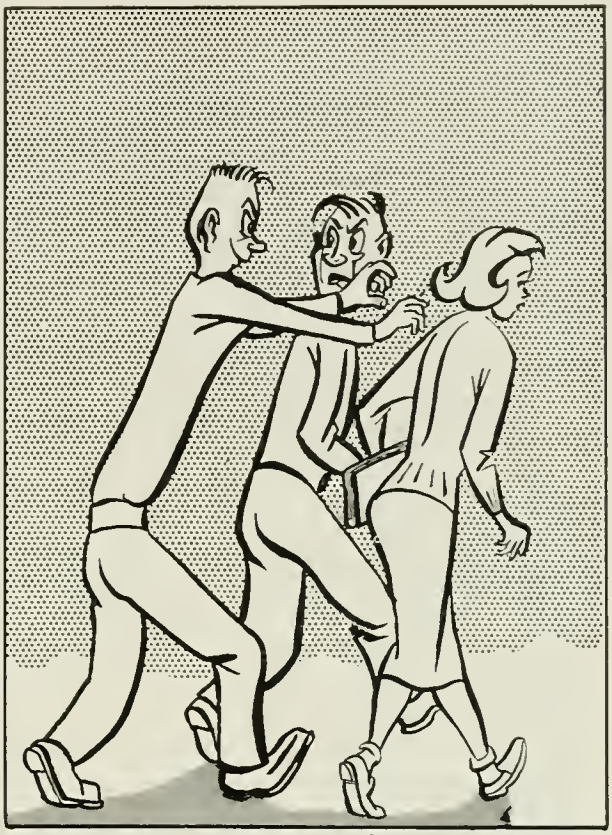
BUT I DON'T SEE HOW DROPPING JUST ONE THING OFF THE EDGE OF THIS ROOF WILL PROVE GALILEO'S LAW!

LOOK, CRENSHAW, ALL I WANT TO DO IS BORROW ONE BUCK FOR A WEEK!

ON CAMPUS

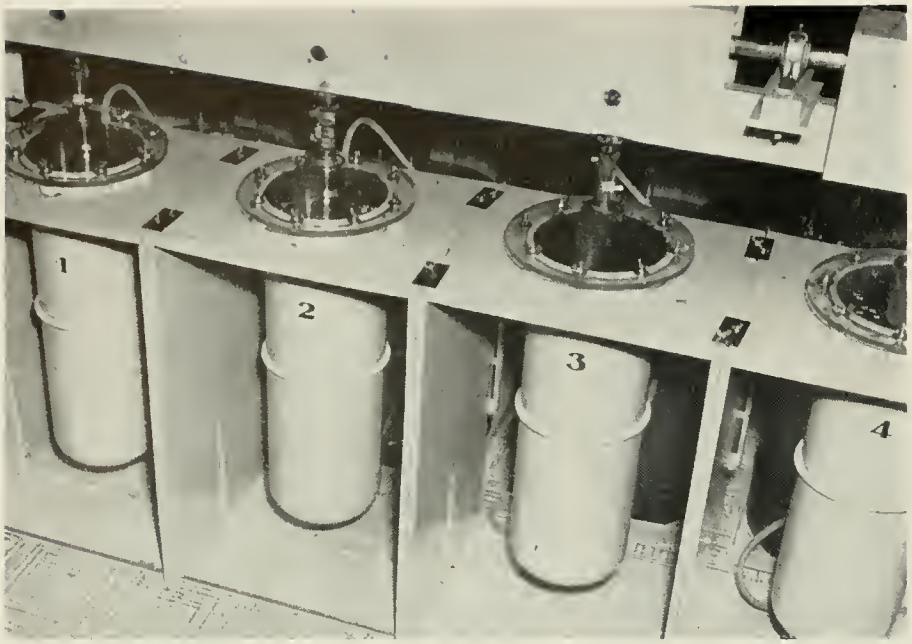
by Dave Templeton

KNOW YOU SAID 'FORMAL' - I CHANGED MY SWEATSHIRT, DIDN'T I?



CRENSHAW, I KNOW WE'RE ROOMMATES; SHARING "THINGS" ENDS HERE AND NOW!

HEY, CRENSHAW, IT'S THE GUY FROM NEXT DOOR. HE WANTS TO TELL US HOW MUCH HE LIKES OUR COMBO!



Battery of continuously stirred digesters. Speeds of stirring could be varied by altering the gearing arrangement.

equipment for work in the hydraulics of sewage and sludge flows, as well as a three-story plumbing installation used for demonstration and research on plumbing practices.

Moreover, not only is the Sanitary Engineering Laboratory well equipped, but its location is also most advantageous to the effective serving of its function. Some two hundred feet to the north is a thirty inch intercepter sewer from which domestic sewage can be pumped to the lab for study and analysis. Running two hundred feet to the south Boneyard Creek provides a source of surface water which can easily be pumped to the lab for similar purposes. Storage facilities within the laboratory are provided by two ten-foot diameter wooden-stave tanks, each having at present a capacity of some ten thousand gallons and a maximum possible capacity of around twenty thousand gallons. Such storage facilities are important in that not only is an abundant supply of either water or sewage constantly available but also they provide for the primary treatment of sewage in the preparation of solids for further studies. These solids can be furnished either fresh or well-digested and are easily collected. Gas from the digestion of such solids can also be collected for anlysis to furnish control data.

The choice of location is also convenient in that septic tanks with sampling wells for use in studies of the type of individual home sewage disposal systems prevalent in many rural or subdivision areas today have been provided without danger of nuisance.

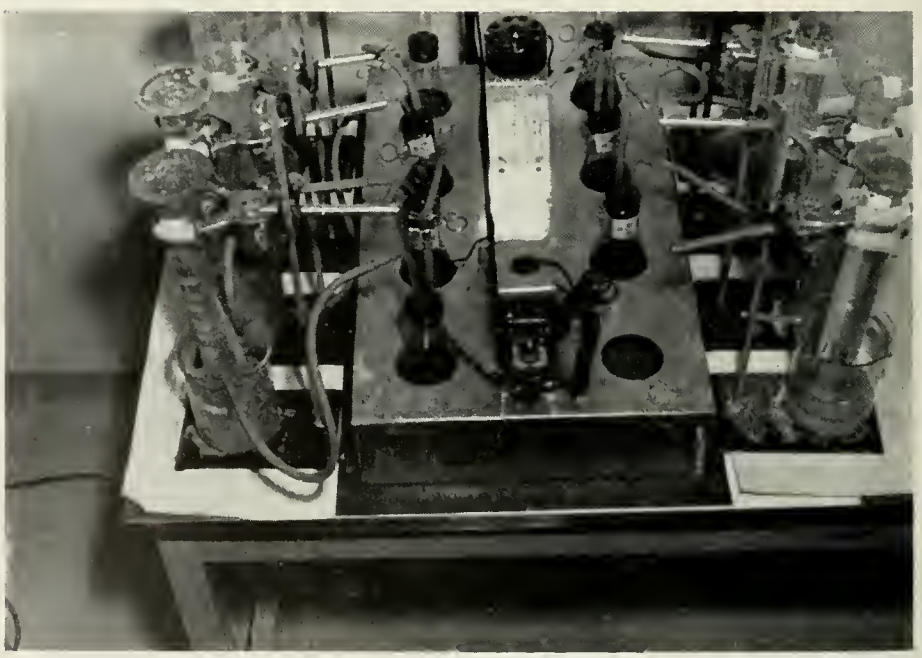
All of these many facilities are used for graduate research, for the instruction of graduate and senior sanitary engineering courses, and for work on contracted projects sponsored by industry. Space is also available for special problems as may be elected by advanced undergraduates in sanitary engineering.

Among the early projects conducted at the University of Illinois (some while the old sewage lab was still in use) were those dealing with sludge and sewage flows in pipes both laminar and turbulent; some of the first studies ever made on the digestion of sewage sludges as a means of treatment; tests and resultant comparisons of various methods of sewage treatment; and research on plumbing techniques based on fundamental hydraulic principles—another "first" in this field of study. The present plumbing arrangement in the lab exemplifies these findings and demonstrates their fundamental principles as well as showing defective plumbing techniques for demonstration purposes.

More recent work includes studies on six small septic tanks; experimentation and formulation of water production principles for gravity wells; studies of varied flow in open channels; the corrosion of copper tube soil stacks; testing of diatomaceous earth filter equipment and attached coagulation chambers designed for the purification of water by army units in the field, research on the treatment of radioactive sewage sludges, and others. The last two are the most recent and perhaps the most interesting.

The studies made on the diatomite filter units were carried on over a period of seven years. This project was contracted from the Engineering Research and Development Laboratories under the auspices of the War Department and the Engineer Center at Fort Belvoir, Virginia. The work was divided into several phases including studies of the effects of coagulation chemicals on the filtration properties of a "raw" (*i.e.*, untreated) water so treated, the use of various parameters in controlling the filtration and the effect of adding body feed (*i.e.*, small amounts of diatomite added continuously to lengthen the filter run).

The general theory of operation and treatment by the unit is quite straight-



View showing batch digester setup. Digestion was carried out on a fill and draw basis. Since many of the samples used in this project were radioactive, they were labeled for identification.

A Campus-to-Career Case History

"Always something new"

"Different types of work appeal to different men," says Donald O'Brian (A.B., Indiana, '50), in the Traffic Department with Indiana Bell Telephone Company. "For me, I'll take a job that keeps me hopping. And that's just the kind of job I have.

"You'd think that after two years I'd have all the variables pinned down. But it doesn't work that way. When you supervise telephone service for thousands of different customers whose needs are always changing, there's always something new coming up.

"I started with Indiana Bell in 1952, after two years in the Army. My training program exposed me to many different kinds of telephone work—customer contact, personnel, accounting, operations. I saw a lot of jobs which looked as interesting as mine. As much as I like what I'm doing now, I bet I'll like my next spot even better."

Don's enthusiasm for his job is pretty typical of how most young college men feel about their telephone careers. Perhaps you'd be interested in a similar opportunity with a Bell Telephone operating company, such as Indiana Bell . . . or with Bell Telephone Laboratories, Western Electric or Sandia Corporation. See your Placement Officer for more information.

BELL TELEPHONE SYSTEM

forward. The raw water is pumped into the lab from the Boneyard Creek nearby. It is then rapidly mixed with ferric chloride and calcium carbonate, chemicals which react to form a heavy gelatinous precipitate. The precipitate, the particles of which are called floc, forms a sludge blanket through which raw water passes. The sludge blanket acts as a "screen" which allows the water to pass through while "filtering" out particles of undesirable organic or gritty matter. Thus, the chemical floc serves as a primary filtration unit similar to coarse screening in a sewage treatment plant. This series of operation (*i.e.*, the rapid mixing, reaction of chemicals during the continuously stirred flocculation period, and subsequent coarse filtration) was performed in the Erdlators. Mixing of chemicals with the water, and then flocculation occurs in the central cylinder.

The resulting sludge blanket forms in the outer chamber and is drawn off at a constant rate. The Erdlator effluent is clear and sparkling and contains only bacteria and micro-organisms. H.T.H. (High Test Hypochlorite), a chemical containing a high percentage of available chlorine, is also added to the Erdlators to provide a sufficient residue in the final effluent. The Erdlator effluent is collected in fifty gallon drums and pumped to the diatomite filter units. The water is then forced under constantly maintained pressure through the septums of these filters upon which is supported the actual filtering agent (*i.e.*, the diatomaceous earth). This material is composed of the skeletons of microscopic

Closeup of an erdlator. 1 — Ferric chloride orifice calibration chart; 2 — Raw water inflow calibration chart; 3 — Raw water inflow manoweter; 4 — Ferric chloride feeder; 5 — Raw water inflow control; 6 — Center column mixer shaft; 7 — Speed reducer gear and motor; 8 — Central mixing chamber; 9 — Outer filtering chamber.

plants which are found in large deposits at the sites of ancient bodies of water in certain areas of the world. It is an ideal filtering material in that by virtue of its very fine flour-like nature it effectually prohibits the passage of any organisms (bacteria included). The septums are made by fusing small brass spheres into porous cylinders. They serve only to support the diatomaceous earth filtering material and to permit the passage of the final effluent which is forced from their outside to their inside.

The length of filter runs varies from one-half an hour to twenty-four or forty-eight hours, depending on the condition of the raw water, the efficiency of the sludge blanket formation and action, and the amount of diatomite filtering material used. Filter runs can be lengthened by adding "body-feed." This is a carefully controlled slurry of diatomaceous earth which is continuously added to circumvent the clogging of the filters by the layering up of foreign matter which has been filtered out.

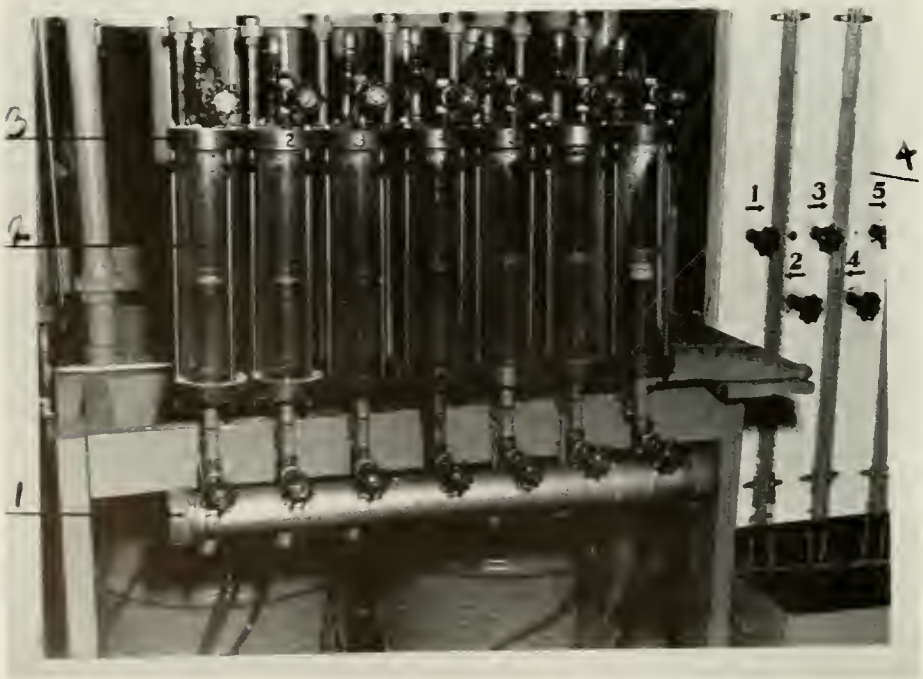
As the pictures indicate, these units are compact and therefore quite flexible and easily moved. This is their intended purpose as the units now in use by the army for water purification in the field are truck-mounted. These army units were to a great extent designed on the information collected in the tests run in our Sanitary Engineering Lab.

While these filtration studies were being made, an investigation was also being pursued in the lab to determine the effect of radioactive isotopes on an important phase in the present-day treatment of sewage sludges, namely digestion. This type of experimentation, let under a two year contract by the Atomic Energy Commission, is of great importance to our security in the atomic age. It is important to learn if present methods of sewage treatment can cope with the treatment of the radioactive wastes which are now present in some domestic sewages due to hospital uses and especially in the wastes produced by nuclear research centers. Such information on the effects to present methods will give us clues to new methods of treatment which will render these wastes safe.

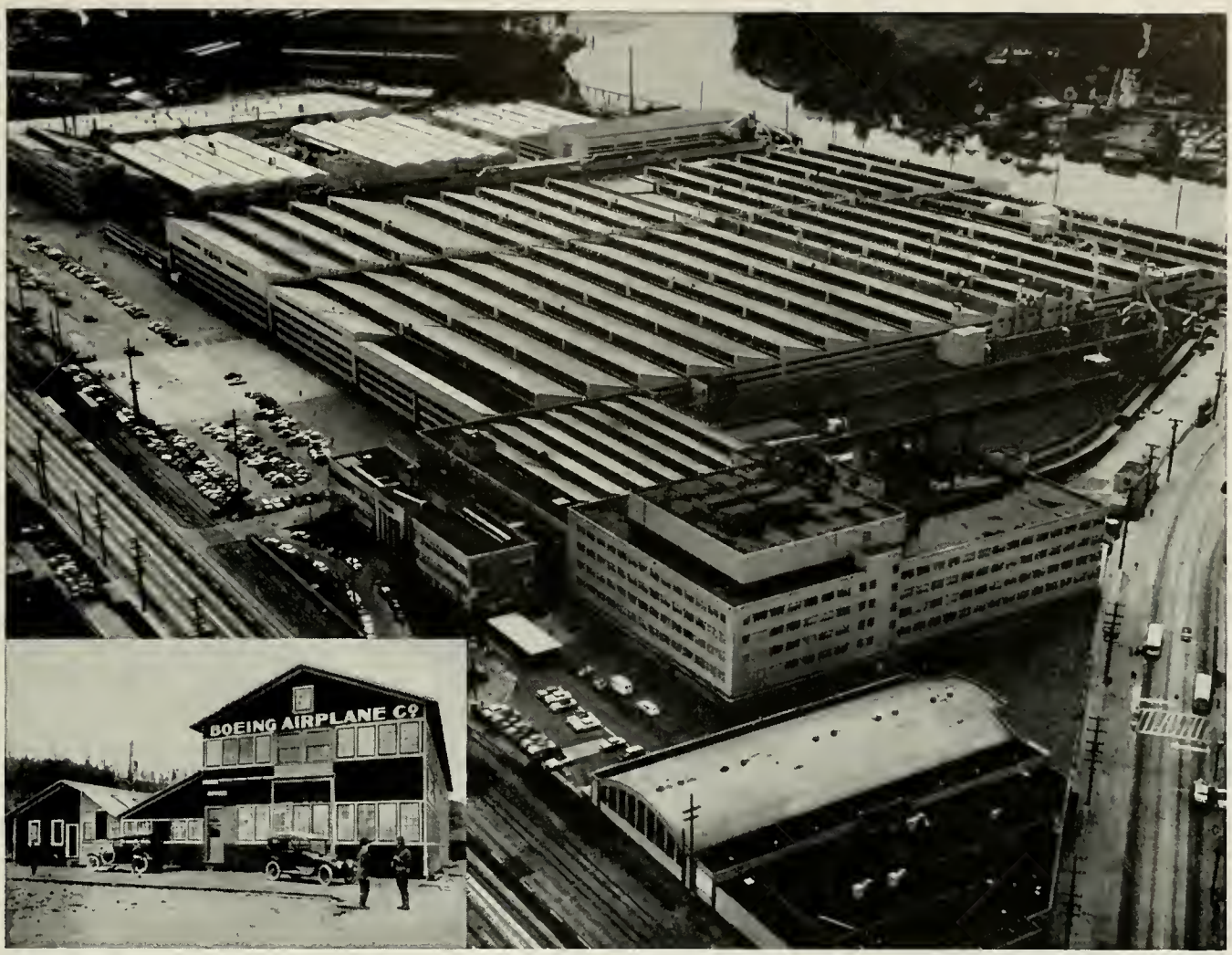
Today sludge digestion is a widely used method of treating sewage sludges. It consists of placing the solids collected from primary settling treatment into a container, called a digester, in which the biological activity of the anaerobes transforms these solids into a material which can then be safely disposed of. These anaerobes are that group of organisms which digests materials in their metabolism without requiring an oxygen supply.

Not only was it important to learn the effects of radioactive materials on the digestion processes, but also to determine the possible effects of that digestion on the concentration of radio-active isotopes—an occurrence which could be dangerous to anyone who might come in contact with the digester material or liquids as well as the operators.

Fresh sewage solids pumped from the intercepter sewer nearby and concentrated in the lab were digested at 92 to



Close up of Diatomite Filter Installation. 1 — Drain; 2 — Filter Septum; 3 — Filter Housing; 4 — Rate-of-Flow Control Panels.

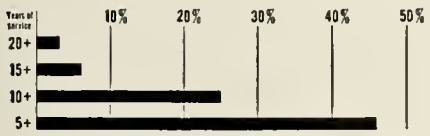


1916—The first Boeing plant, Seattle

1954—Boeing's Seattle plant as it appears today. New Engineering Building is shown in foreground.

Is career stability important to you?

Then the chart below will be of interest. It shows that 46% of Boeing's engineers have been with this company for five or more years; 25% have been here 10 or more years, and 6% for 15 years.



One reason for this stability is that Boeing has grown steadily for 38 years, providing plenty of room for advancement. Another reason is the highly interesting type of work at Boeing, such as designing and building America's first jet transport and the revolutionary B-47 and B-52 jet bombers, as well as work on pilotless aircraft, supersonic flight and research in nuclear-powered aircraft.

Still another reason is this: Boeing always has put dominant emphasis on engineering development. Pioneering in this field has meant that Boeing constantly has increased its engineering staff in relation to total employees. Fifteen years ago, one out of 16 employees was in engineering. Five years ago the proportion of engineers had been raised to one in ten and today it has climbed to one in seven.

Boeing has rewarding openings for engineers of EVERY category—electrical, civil, mechanical, aeronautical and related fields, as well as for applied physicists and mathematicians with advanced degrees.

Careers at Boeing afford a wide variety of experience in research, design and production, as well as work with new materials and techniques, and contacts with a cross section of industry through Boeing's vast subcontracting program.

Boeing promotes from within and holds regular merit reviews to assure individual recognition. Engineers are encouraged to take graduate studies while working and are reimbursed for all tuition expense.

For further Boeing career information consult your PLACEMENT OFFICE, or write

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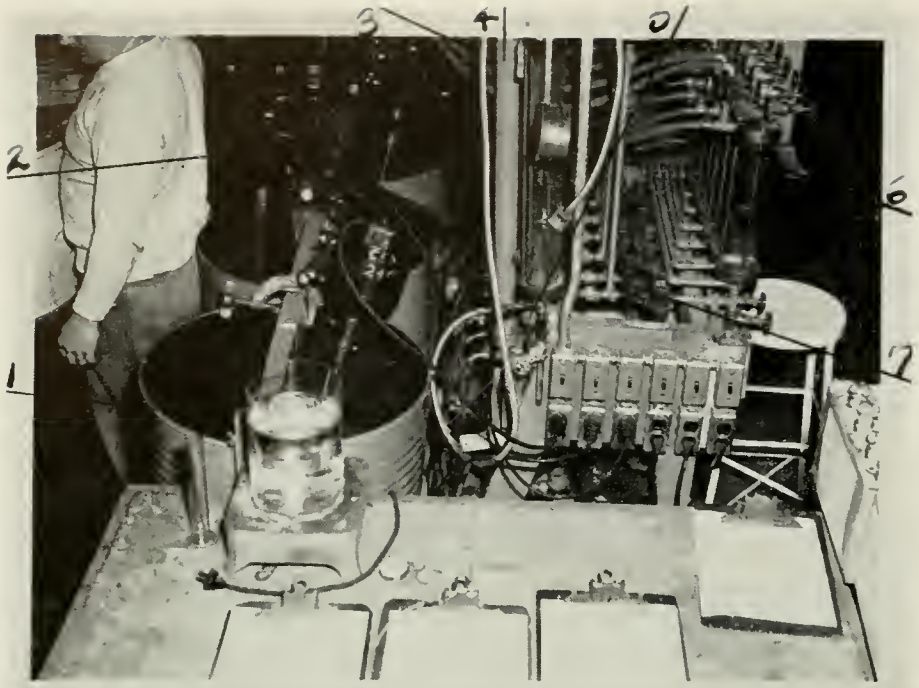


Closeup of Rear of Filter Apparatus showing body-feed units. 1— Body-feed Tanks; 2 — Body-feed Stirrers; 3 — Manometer lines; 4 — Body-feed Surge Tanks; 5 — Manifold; 6 — Filter Housings; 7 — Pressure Regulator.

102°F. The radioactive materials added were P^{32}, I^{131}, S^{35}, and Ca^{45}. The digestion was measured by standard parameters, namely gas production, volatile acids, pH, and solids analysis. Microscopic studies were also made to correlate these results with the type of radioactivity of the isotopes present.

Phases of testing included studies of the effects of radioactivity on batch (*i.e.*, fill and draw) digesters, continuously fed digesters, and digesters stirred at various rates of speed. The results varied, depending upon the isotopes used. Most of these radioactive materials had little effect upon the processes of digestion except when present in extremely high levels. In most cases the radioactive materials were found in the sludge portion of the mixture, except in one case in which they appeared in a greater proportion in the liquids produced. In general, little effect upon the organisms responsible for sludge digestion occurred because of the radioactive materials added.

Such work is valuable in pointing the way to better methods of treatment of the many wastes, some quite dangerous, that are encountered today.

However, not only is the lab the scene of research but also it provides facilities for the teaching of sanitary engineering courses. Graduate and undergraduate laboratory facilities are available and find constant use. In addition to this, the Sanitary Engineering Lab serves as the center for annual short-courses offered to plumbers, sewage plant operators, and water works operators. Attendance at these meetings, sponsored in cooperation with the University of Illinois Division of Extensions, furnishes men in the field with information on the most recent developments with practice in standard testing techniques.

Because of its many facilities for teaching and research, the Sanitary Engineering Laboratory is an important part of the educational provisions available at the University of Illinois. Few other institutions can boast of such extensive facilities or of the achievements attained. However, there is no significant place for clipping scrapbooks in scientific progress, and therefore the lab is constantly proceeding in the search for better methods of water and sewage purification.

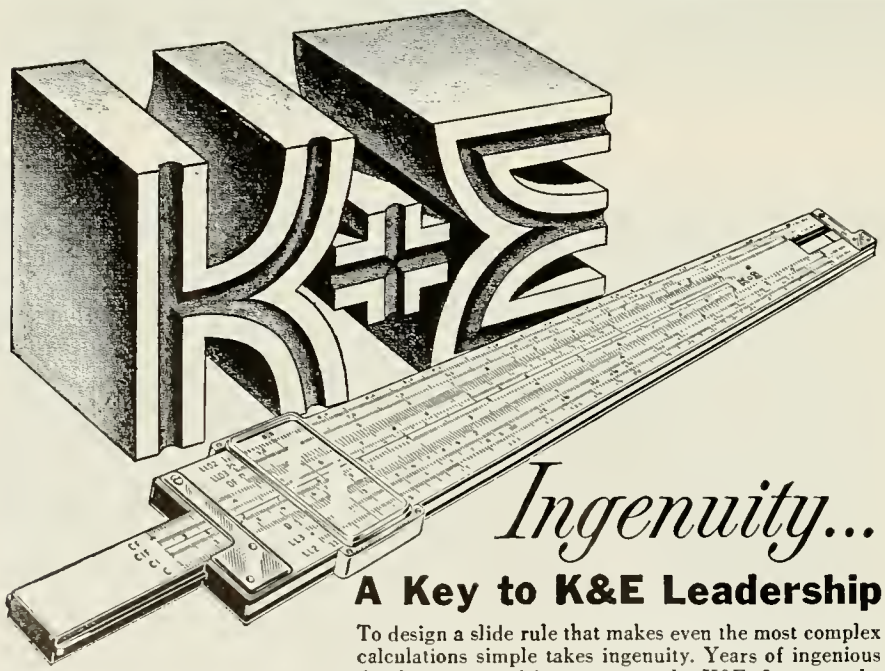
The efficiency expert died after many years of faithful service, and his company had arranged an elaborate funeral. The pallbearers were carrying the casket out of the church when, suddenly the coffin lid popped open and the expertsat up and said, "If you put this thing on rollers, you can lay off four men."

* * *

The Sunday-school teacher had asked her class where God lives. One small boy replied "He lives in our bathroom."

"Why, Jimmy, what makes you say that?"

"Well, every morning my pop stands in front of the bath room door and says, 'God, are you still in there?'"



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at Ramo-Wooldridge

The Senior Staff of The Ramo-Wooldridge Corporation, shown above, is comprised of scientists, engineers, and science administrators with outstanding records of past performance in positions of responsibility. By means of meetings of the entire group, supplemented by frequent smaller sessions, these key men participate actively in the establishment of company plans and policies.

Existing project commitments require that the current rapid rate of expansion of the company continue throughout the coming year. Unusual opportunities, encompassing a wide variety of challenging research and development problems, exist for *additional* scientists and engineers who would like to participate in the development of a company in which, from the outset, all features of the organization and of the operational procedures are designed to be as appropriate as possible to their special needs.

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FINGER TIP CONTROL

by Orval W. Clausen, M. E. '56

More and more in the recent years, the emphasis in the automotive industry has been on driver comfort. This emphasis has caused the introduction of automatic transmissions, power steering, and finally power brakes, and is now causing their development to increase rapidly enough to keep pace with the other phases of the industry.

Some of the most important advances along this line have been in power steering. Not very long ago, power steering was used only in heavy trucks and was considered impractical for the automobile. Yet today, almost every make of car has power steering offered at an optional cost, and some manufacturers are making it standard equipment. What has caused this trend, and just how does power steering work?

In order to give cars better riding characteristics, the passenger space in the present day automobile has been placed farther forward, and the tires now used are of the large contact area, low pressure type. To overcome this added steering resistance, the engineers have had to increase the steering ratio, that is, the number of turns of the steering wheel to the angular deflection of the wheels. However, the steering ratio of the standard mechanical system is limited by several physical factors, among which is the diameter of the steering wheel. Power steering overcomes these factors and reduces the ratio much more than is conveniently possible with mechanical means, thus eliminating unnecessary "cranking" of the wheel.

Also instrumental in the development of power steering are considerations of safety as well as comfort. When a tire blows out unexpectedly while driving with conventional mechanical steering, the full turning force is transmitted directly to the steering wheel. However, with power steering, as much as 80 per cent of the force is cushioned by the power unit. This means that the driver doesn't suddenly find the wheel jerked from his hand, but that he can maintain control with a minimum of effort on his part. The power unit also cushions 80 per cent of annoying road bumps thus cutting down driver fatigue tremendously on long trips.

The two basic types of power steering units are the integral type and the linkage type. The integral type has the valves and power cylinder incorporated with the steering gear, though the pump and reservoir are separate. The linkage type has the power cylinder, resembling a shock absorber, down beside the regular steering linkage. The valves may be in the cylinder or at the pitman arm. Each type has certain advantages and disadvantges which will be discussed more fully later in this article.

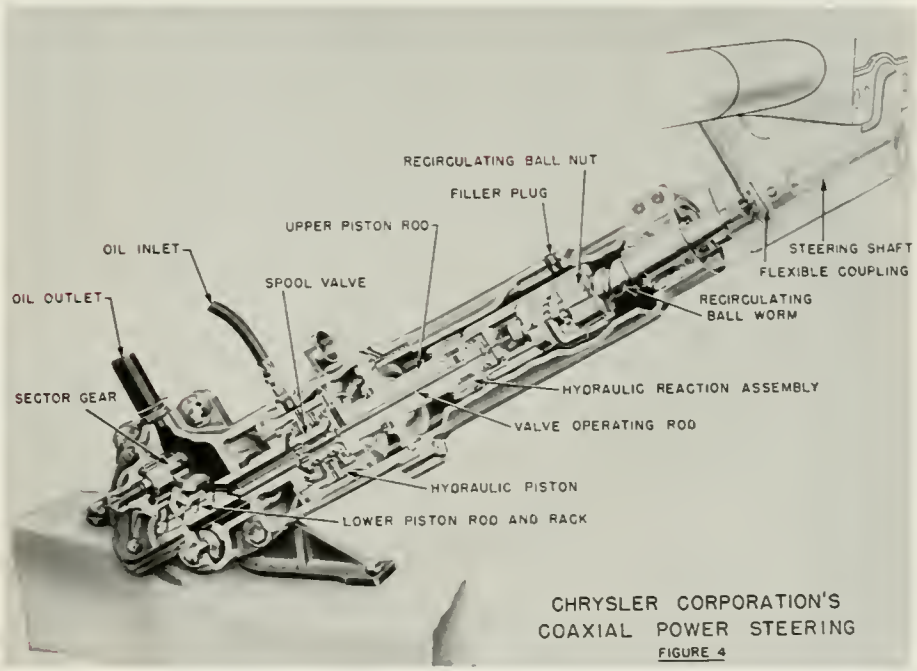
The linkage type power unit, used in the beginning by Chrysler Corporation, proved to be not quite as good as the integral type unit. Almost all leading car manufacturers today use the integral type unit. The following paragraphs discuss the differences in the two major types of power steering used today.

The first integral type power unit, used in Chrysler products, has two main parts: the spool valve and the spool valve body or piston. The relative movement between these two parts, seldom exceeding 0.0025 inch, completely controls the movement of the wheels.

When this integral type power unit is in neutral valve position, the openings between the valve and the piston are open and oil can flow through the unit quite easily at low pressure. The oil entering is divided equally on each side of the piston causing an equilibrium condition or no further movement of the wheels.

When the steering wheel is turned, two very important things take place. First, the oil pressure is built up because the openings between the valve and the piston have been restricted. Secondly, the movement of the steering wheel causes the high pressure oil to be directed toward one side of the piston. The oil is restricted at points on the left hand side of the piston. This high pressure oil forces the piston which is connected to the sector gear to move to the right, the movement of which steers the car.

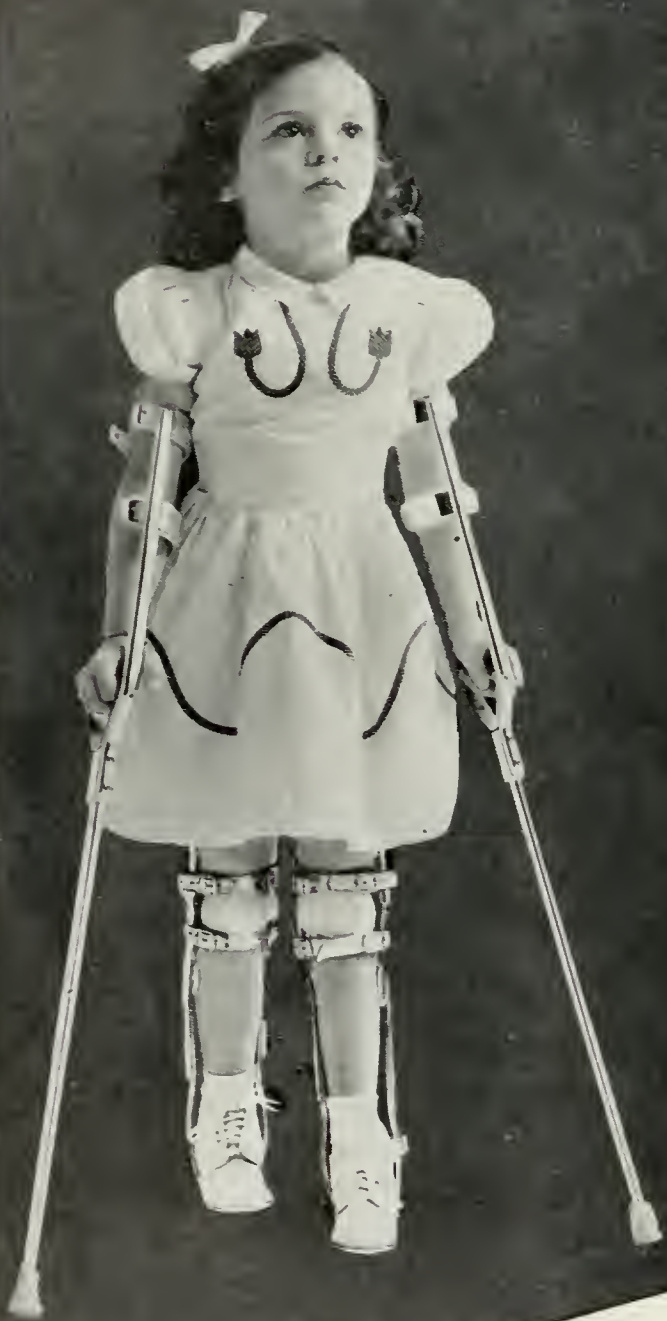
When the driver stops turning the steering wheel, the valve is immediately held fixed; but the piston keeps moving



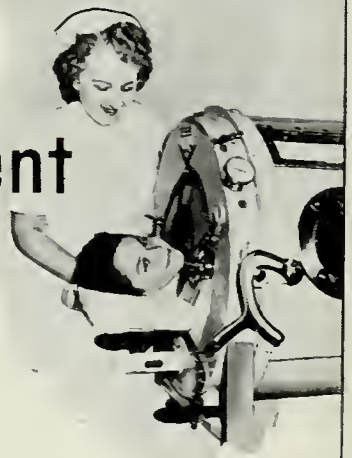
CHRYSLER CORPORATION'S COAXIAL POWER STEERING
FIGURE 4

The new type of power steering unit uesd by Chrysler. Note the hydraulic reaction assembly which gives the driver the "feel" of the road.

FIGHT POLIO!



prevention



treatment

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Carl Vrooman, icing tunnel group head, studies hot-air cyclic de-icing test on wing section of C-130 transport. The tunnel has a temperature range of —40° F. to +150° F. and maximum air speed of more than 270 mph.

New icing tunnel speeds thermodynamics research at Lockheed

Designed to meet a constantly increasing volume of thermodynamics work, Lockheed's new icing research tunnel now provides year 'round testing in meteorological environments normally found only in flight. It is the first icing research tunnel in private industry.

Lockheed thermodynamics scientists were formerly limited to testing time available at installations such as Mt. Washington. Now they are able to study in greater detail problems such as: thermal anti-icing; cyclic de-icing; various methods of ice removal; distribution of ice; rate of temperature changes in aircraft components; thermodynamic correlation between laboratory and flight testing; and development and calibration of special instrumentation.

C. H. Fish, design engineer assigned to the tunnel, measures impingement limits of ice on C-130 wing section. The tunnel has refrigeration capacity of 100 tons, provides icing conditions of 0 to 4 grams per cubic meter, droplet sizes from 5 to 1000 microns.

Thermodynamicist Ed Dean monitors main control panel in picture at left. Temperature, air speed, water flow rate, air pressure and other variables can be regulated independently.

B. L. Messinger, department head, analyzes test results with Thermodynamics Engineer E. F. Versaw, right, and Thermodynamicist Tom Sedgwick, left. The report was in their hands *only two days* after it was decided to conduct the test.

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under the pressure of the oil. However, this additional movement causes the restrictions to open up again and equalizes the pressure on each side of the piston. The piston then comes to a stop with no further turning of the wheels. Although this operation is explained in steps, it actually occurs almost instantaneously because the relative movement between the piston and the spool valve is so slight.

Another feature of Chrysler Corporation's power steering is the hydraulic reaction chamber. This chamber is designed to give the driver the "feel" of the road, small enough to reduce fatigue and yet large enough to eliminate the possibility of oversteering. Oversteering is an acute problem to the driver who has never before driven with power steering.

Two important facts must be remembered when considering the operation of the hydraulic reaction chamber. First, the spool valve in the power unit itself is connected mechanically to the steering wheel. The slightest movement of the steering wheel is transfered through the ball nut to the spool valve. Secondly, the ball nut is connected hydraulically to the upper piston rod. This connection is called the hydraulic reaction chamber.

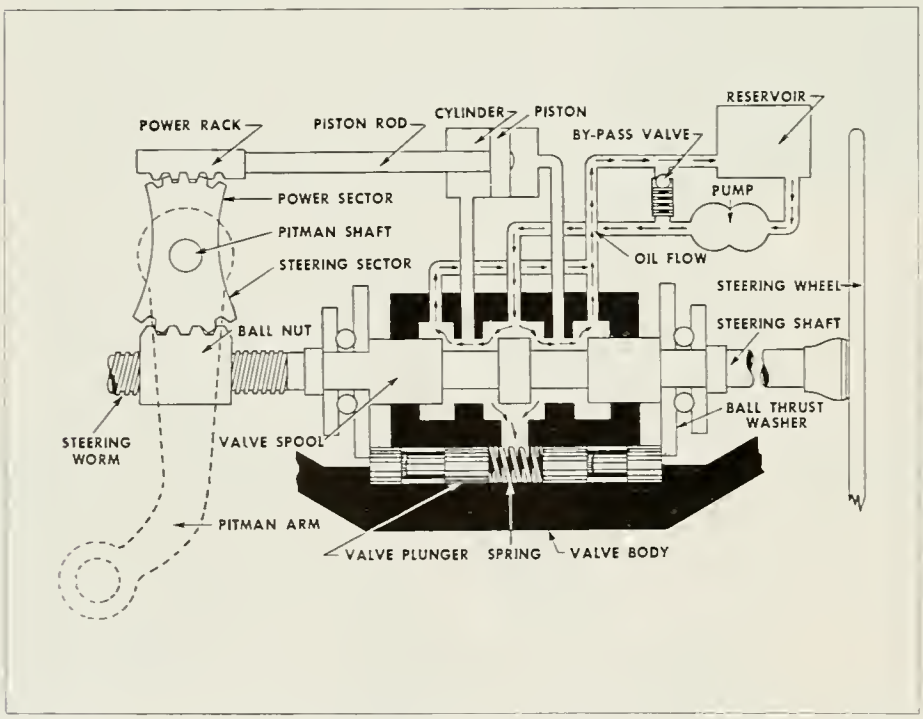
As the driver turns the steering wheel in such a way to cause the ball nut to move to the right, the ball nut pushes on the lower reaction ring and squeezes the reaction seal. Oil is at a low pressure because it is supplied from the main power unit, and the main unit is in neutral valve position. However, as the pressure builds up in the unit, it also builds up in the chamber. This reduces hydraulically any forces that might be transmitted to the driver when turning. It should be kept in mind that any slight jar puts this system in action and that all the steps explained here occur, for all practical purposes, simultaneously.

The second integral type power steering, used in General Motors' products, acts a little differently from the other type. Instead of the unit helping the driver with the slightest amount of pull on the steering wheel, General Motors' power steering doesn't take effect until a pull of about three pounds is exerted. That means that the power booster does not come into action until the driver is really in need of it. It also means that the driver has the "feel" of the road just as he would with conventional steering, except when turning or in an emergency.

When the unit is in neutral valve position, the valve plungers hold the valve spool in a central position. This position allows oil to flow from the pump unrestrictedly through the unit and back to the reservoir. The pressure on each side of the piston is equal, and there is no movement of the piston or turning of the wheels.

However, when the steering wheel is turned, the force overcomes the valve plunger, and th valve spool is pulled to one side or the other. This leaves just one path open to the oil and that is to one side of the piston or the other. The piston, connected mechanically to the sector gear, starts moving, thus turning the wheels. As the driver stops turning the steering wheel, the valve plunger again overcomes the force and returns the mechanism back to neutral valve position.

Power steering is rapidly becoming more than just an accessory. People are beginning to realize the hazard of driver fatigue and are trying to remedy it as much as possible. The number of accidents caused by driver fatigue can't be exactly evaluated, but common sense indicates that it plays an important part. Power steering definitely is not in the gadget class—it is here to stay.



The power steering mechanism used by Chevrolet. Drawing shows unit in neutral valve position.

The little fellow sat up in his nursery crib and called to the baby in the adjoining crib: "Did you throw water into my crib?"

"Not me."

"Hmm — must have been an inside job."

* * *

Of all the "Give me a sentence with a word" jokes we've heard, we give the prize to the lad that put effervescent and fiddlestick in one sentence. "Effervescent enough covers on your bed, your fiddlestick out."

* * *

The battleship was in port and visitor was being shown around. The guide was explaining a bronze tablet on the deck.

Guide: "This is where our gallant captain fell."

Visitor: "Well, no wonder, I damned near tripped over it myself."

* * *

1st farmer: "Potato bugs ate my whole crop in ten days."

2nd farmer: "They ate mine in two days, then roosted in the trees to wait until I planted some more."

3rd farmer: "That's nothing. Right now there's a potato bug going through my books to see how many plantings I've ordered for next spring."

* * *

Sherlock Holmes: "Ah, Watson, I see you have on your winter underwear."

Watson: "Marvelous, Holmes, marvelous. How did you ever deduce that?"

Sherlock Holmes: "You forgot to put on your trousers."

* * *

This joke is dedicated to all the outgoing seniors and to all the juniors who wish they were outgoing seniors too.

One of our profs returned from lunch just recently in a very good humor, and he called the whole class together to hear a few of his latest finds. Everyone but one of the students laughed uproariously. "What's the matter?" grumbled the prof. "Haven't you any sense of humor?"

"I don't have to laugh," said the senior. "I'm leaving Friday anyhow."

Opportunities for a Career with

National STARCH PRODUCTS Inc.

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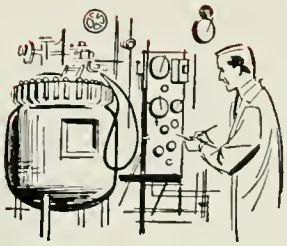
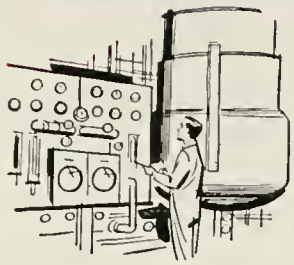
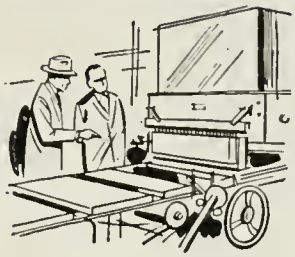


process development and engineering



production



technical sales and service

ON THE MOVE...

—American Point Journal November 1, 1954

Nat'l. Starch To Build Vinyl Resin Plant

New York, Oct. 25.—Frank Greenwall, president, National Starch Products, Inc., announced that the company has purchased a tract of land at Meredosia, Ill., for the construction of a second vinyl resin plant. This plant will supplement the production of their Plainfield, (N. J.) resin plant.

The company plans to manufacture principally vinyl acetate polymers and copolymers at this new location. This expansion will permit National to be in a better position to supply these widely used resins in the western markets.

Above—Recent news of National's continuing expansion in the production of resins, industrial adhesives and starches.

CHEMISTRY (B. S. Degree)—Opportunities in applied research, analytical work, product development and customer technical service.

CHEMICAL ENGINEERING (B. S. Degree)—Opportunities in production, process development and customer technical service.

SALES (A. B. or B. S. Degree, including business administration)—Opportunities in the field of industrial sales.

Dr. W. V. Upton will interview on March 3, 1955.

STARCHES National ADHESIVES
RESYNS®

National Starch Products Inc., 270 Madison Avenue, New York 16, N. Y.

by Donnie Snedeker, M. E. '58 and Jim Piechocki, Aero '56

MILLARD DARNALL

Millard Darnall, associate editor for the *Illinois Technograph,* was born and raised in Minier, Ill. Being raised on a farm he became interested in Agricultural Engineering, and is now a second semester junior in that curriculum here at the U. of I.

Millard was editor of the Minier High School newspaper, which gives him a good background for his present position on the Technograph. He is a member of the American Society of Agricultural Engineers, and has worked hard on the Engineering open house. Starting as a freshman, he has worked on the Technograph staff for two years.

MILLARD DARNALL

During the summer Millard likes to experiment with farm machinery while helping his father with the farm. Next summer he is planning to work for the John Deere Farm Implement Company at Moline, Ill.

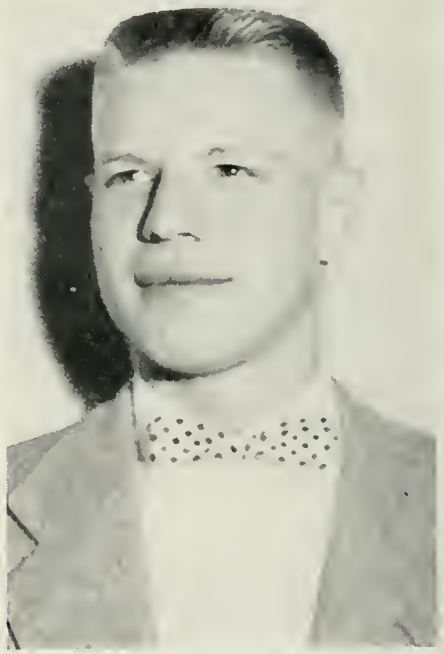
Millard also has activities other than those pertaining to engineering. He is interested in sports and while in high school he was captain of the basketball team for two years. He now is very active in Intramural sports. In his spare time ,which he hasn't much of, he likes to listen to Dixie land music or play it on his saxaphone.

In addition to these activities, he is president of Tau chapter of Delta Phi fraternity. This position requires a lot of time and carries a great deal of responsibility.

In spite of these many activities. Millard has maintained a four point grade average in his first five semester at the University of Illinois.

RICHARD BEMIS

There is nothing more distinctively eye-catching than a blond with a crew-cut. But this is only one minor detail when it comes to evaluating the personality of Dick Bemis, EE par excellence. Born in Flint, Michigan, in February 28, 1933, (". . . Flint is the second largest auto city in the country," proudly relates Dick) this very active electrical engineering student started his electronics career at the age of fourteen as a student in a fundamentals-of-radio course offered by the local radio service man. By this time he had already built the usual beginner's crystal set and code practice oscillator. His keen interest in electricity was developed even further in high school where he took more courses in radio fundamentals. At the age when most young men are concerned chiefly with football and baseball, Dick was spending a great amount of time building and servicing electronic devices. All this, of course, done in addition to his extra-curricular activities which even included a successful crack at the debating team along with a part time job in a supermart. After becoming sold on the idea of college, he decided to do it the Navy way, and hence applied for and received a four year

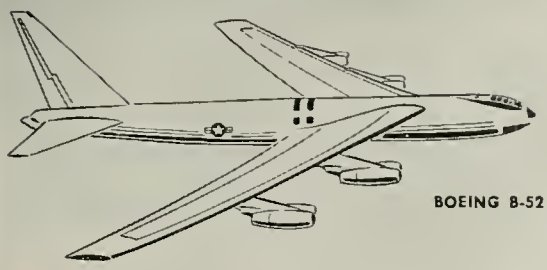


RICHARD BEMIS

U. S. Navy scholarship. From here on in he continued to advance. As a junior he was invited into the ranks of the EE Honorary, Eta Kappa Nu, and the engineering honorary, Sigma Tau. A short time later he became a member of Tau Beta Pi.

At the present, this blond dynamo is engaged to a young school teacher from the Chicago area, who, incidentally, received her degree from the University of Illinois. Dick also occupies himself with such tasks chairman of the student branch of the AIEE and vice president of Eta Kappa Nu. But by far his biggest job at the moment is the general chairmanship of Engineering Open House for the Spring of '55. ". . . . the biggest and the best," is the way he sums up his goal for the annual engineering extravaganza.

Being a member of the NROTC unit at the U. of I., Dick's summers have been filled with enjoyable cruises to such delightful spots as Scotland, France, Cuba, England, and Ireland,



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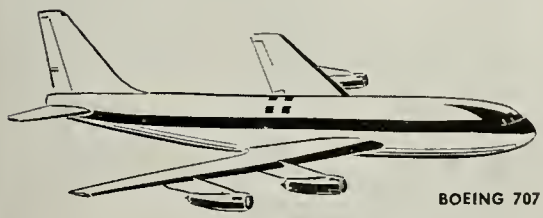

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These planes are some of America's newest, biggest, best — setting new standards for speed, maneuverability, reliability.

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Sandia Corporation engineers and scientists work as a team at the basic task of applying to military uses certain of the fundamental processes developed by nuclear physicists. This task requires original research as well as straightforward development and production engineering.

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Sandia engineers design and develop complex components and systems that must function properly under environmental conditions that are much more severe than those specified for industrial purposes. They design and develop electronic equipment to collect and analyze test data; they build instruments to measure weapons effects. As part of their work, they are engaged in liaison with the best production and design agencies in the country, and consult with many of the best minds in all fields of science.

Sandia Laboratory, operated by Sandia Corporation under contract with the Atomic Energy Commission, is located in Albuquerque — in the heart of the healthful Southwest. A modern, mile-high city of 150,000, Albuquerque offers a unique combination of metropolitan facilities plus scenic, historic and recreational attractions — and a climate that is sunny, mild, and dry the year around. New residents have little difficulty in obtaining adequate housing.

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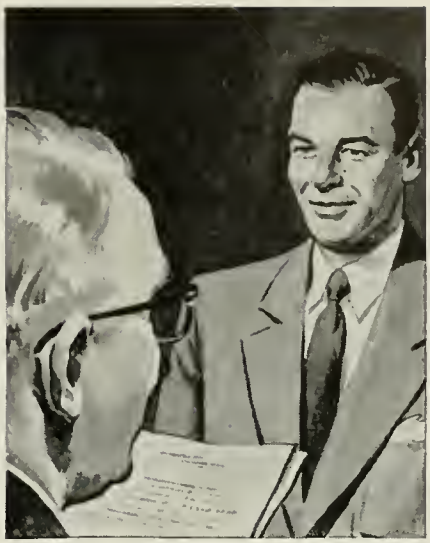

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5 With Delco's policy of promotion from within, your opportunities for advancement are virtually unlimited. Not every trainee becomes a supervisor, but some go much farther. Many General Motors top executives today are "graduates" of Delco Products Division.

If this opportunity interests you, sign up for the GM interview on your campus and ask for referral to Delco Products. For booklet detailing Delco's engineering activities, write to:

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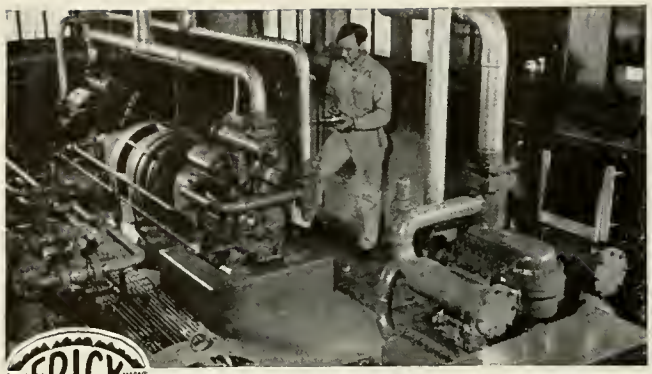

FRICK

REFRIGERATION HELPS MAINTAIN 5,000 M.P.H. SPEEDS IN WIND TUNNELS

For testing aircraft at speeds up to 5,000 m.p.h., the National Advisory Committee for Aeronautics operates several large wind tunnels at Ames Aeronautical Laboratory near San Francisco.

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$50 Awards

The Illinois Technograph is offering $50 prizes for the best staff article and the best non-staff article. Entries must be submitted before March 1, 1955.

Articles must be original, must pertain to engineering, and must be double spaced typewritten.

☆ ☆

For details see the

NOVEMBER TECHNOGRAPH

or call Don Kesler, 7-7085. (After 5.)

which included memorable days in Paris and London. And what significant conclusions does he come to as a result of these foreign excursions? "The best place to be in is the United States of America," he flatly states.

It's been a long time since that first crystal set, and as for the road ahead, it looks promising for this truly all-around individual. The Technograph salutes engineer extraordinary — Dick Bemis.

AL SHINER

The guy with a camera in one hand, a slide rule in the other, and the ambition to combine the two into a career is Al Shiner.

Al, Chicago, editor of the *Technograph*, is a fifth semester ME. And, when he isn't busy pounding on a typewriter, he finds time for the ASME, the Engineering Council, and the Activities Honorary Society. He also spent a number of semesters on the Pier Illini staff, acting first as photo editor and later as managing editor.

With Al, photography is not only a hobby, but a paying profession as well. He has put himself through school with money earned in outside photography jobs. He spent four years on the "Herald American" as a copy boy and finally as a dark room technician. Last summer Al was a sound operator for the International News Service.

His journalistic interests won him the reputation for being the only boy to get an A plus in journalism at the Chicago Jewish Academy where he attended high school. It was here that Al gained a great deal of his newspaper experience when he served as managing editor, make-up, photo, and sports editor on the school paper. For variety, he played first base on the school baseball team.

When asked about himself, Al grins and gets a devilish gleam in his eye and says, "I wore braces on my teeth for five years, get dirty looks from the barber who cuts my hair (a very short crew cut), want to use photography in engineering, and would like to earn $125 a week."

ALLEN SHINER

Demure Young Thing: "Oh, what kind of an officer are you?"

Officer: "I'm a naval surgeon."

Demure Young Thing: "Dear, dear, how you doctors do specialize!"

* * *

"I'll never forget the morning we first reached Niagara Falls," confided young Mrs. Jones. "My husband's face dropped about a mile." "You mean to say he was disappointed?" asked her close friend incredulously. "Not at all," Mrs. Jones assured her. "He fell over the rim."

* * *

Everybody knows what a WAC is, but only the favored few know the meaning of a woc. It's something you thwow at a wabbit.

Richard J. Conway, Lehigh '51, selects Manufacturing Engineering at Worthington

RICHARD CONWAY checks cutting tool with machinist before milling a pump casing.

After completing his general training which brought him in contact with all departments, Richard J. Conway decided that manufacturing engineering was his field. He says, "I chose the Manufacturing Engineering Department after completing my general training at Worthington because as a graduate in Industrial Engineering I can learn the practical aspects of my field while applying theory I learned in college.

"The personnel of this department work together as a team toward the solution of the numerous problems which arise daily. We have the cooperation of all other departments in the corporation in getting the necessary facts pertinent to the solution of these problems. In the course of our day it may be necessary for us to meet the Plant Manager, Chief Engineer, Comptroller, several department heads, clerks, foremen, machinists and many others throughout the company.

"I have contributed to the solution of many problems handled by this department including metal spraying, machining procedures, purchasing new equipment and designating proper dimensions to obtain desired fits between mating parts.

"I enjoy my work because I'm doing the work I want and my formal education is being supplemented with practical knowledge gained from the tremendous wealth of knowledge available to me at Worthington. I know from personal contact with many other departments in the Corporation that Worthington can and will find their young engineers a spot which will give them the same opportunities as have been afforded me."

When you're thinking of a good job, think *high*—think *Worthington.*

FOR ADDITIONAL INFORMATION, see your College Placement Bureau or write to the Personnel and Training Department, Worthington Corporation, Harrison, N. J.

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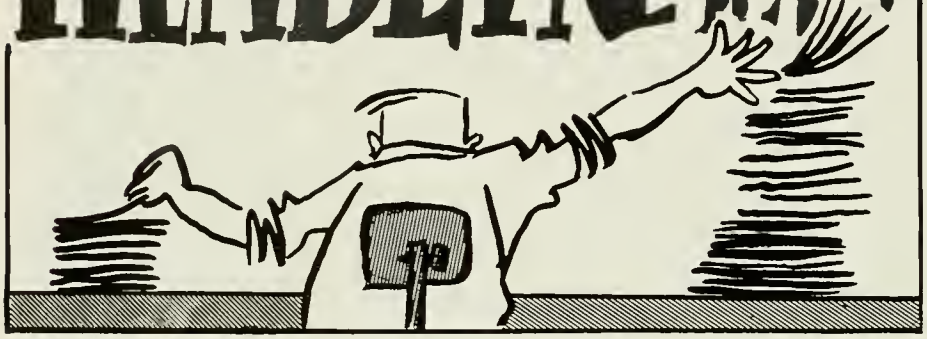


by Larry Kiefling, M. E. '56

Tri-Sonic Wind Tunnel

North American Aviation, Inc. began foundation work on a $5,000,000 wind tunnel today to test airplane and missile designs for the future at speeds up to three and one-half times the speed of sound.

Expected to be one of the nation's largest, privately owned wind tunnels, the facility will play a key role in solving increasingly complex design problems for swifter, more efficient airplanes and missiles.

Large enough to test models up to four feet wide of airplanes and their major sections, the tunnel will provide basic data to guide North American design engineers and will be used for laboratory tests to new airplanes and missiles before they fly.

Significantly, the tunnel is designed for rapid conversion to speed ranges below, equal and above the speed of sound. Most tunnels now in use are built for permanent operation in one of the speed ranges. North American engineers believe the company's three speed tunnel will influence future design time.

The facility's test chamber will be seven feet square and 17 feet long. It will be the nation's largest intermittent, blow-down type wind tunnel, with speeds produced by compressed air rushing from eight steel spheres. Each sphere will be 38 feet in diameter.

The tri-sonic tunnel will be the newsearch facilities in the Los Angeles area. est of North American's extensive re- In use for several years have been a large sub-sonic test facility for exploratory work at low speeds and a supersonic wind tunnel with a small test chamber. Both played key roles in the development of the F-86 Sabre Jet series and the supersonic F-100 Super Sabre.

This facility is scheduled for completion in March, 1956.

Electrolytic Cobalt

As a result of improvements in refining techniques, The International Nickel Company of Canada, has initiated production of electrolytic cobalt at its Port Colborne refinery. This is the first commercial production of electrolytic cobalt in Canada.

Heretofore Inco's entire cobalt output has been marketed as oxides and salts produced at its Clydach, Wales, refinery. Through its new process the company makes available a high purity cobalt which is a fitting companion to its electrolytic nickel. This electrolytic cobalt will be particularly valuable in the manufacture of alloys where high purity is advantageous.

The electrolytic process for the production of cobalt was developed after extensive research and pilot plant studies by the company.

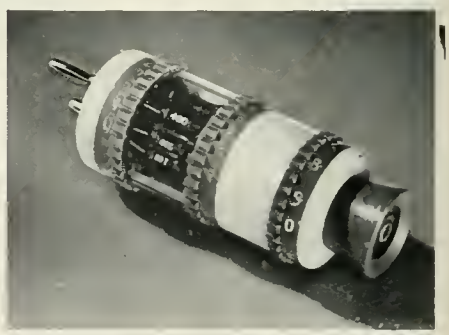
Cobalt is one of 13 elements recovered from the company's Sudbury District, Ontario, ores. Nickel, of course, is the principal product. The others are copper, platinum, palladium, ruthenium, iridium, rhodium, gold, silver, selenium and tellurium. In addition, Inco furnishes high quality smelter gas for conversion into liquid sulphur dioxide and normal smelter gas for sulphuric acid production.

Resistor for Computers

Production of a plug-in decade resistance unit for use in analog-computing equipment, circuit developments and specialized work in electrical engineering laboratories has been announced by Telex, Inc., national manufacturers of hearing aids and electronic components in St. Paul, Minnesota.

Trade-named GEDA and designed by the Goodyear Aircraft Corporation and Telex, the unit was miniaturized in the Telex laboratories through the use of printed circuitry. Size of the original unit was miniaturized by half. A clear plastic band has been substituted for the GEDA label in the photo to show the interior.

Units are available in four stock types—with maximum resistance value of 1 and 10 megohms and 1 and 10 kilohms—but can be built to other specifications if desired. Set resistance value to 1% tolerance is shown on the unit's three dials, with the top dial controlling a potentiometer which permits the unit



This miniature decade resistance unit was designed for use in modern analog computing equipment and electrical engineering laboratories. It is now in production.

to be set to within 0.1% of any range value using a suitable resistance bridge. Each dial has raised knurling along one edge for ease in setting.

Housed in a lightweight plastic cylinder, the unit has an overall length of 4" and a diameter of 1½". The unit is equipped with a jack at the top and two banana plugs at the bottom; plugs are on standard ¾" centers. Two raised plastic pads on the shoulder of the unit may be roughened with emery cloth for temporary pencilled recordings of the resistance value.

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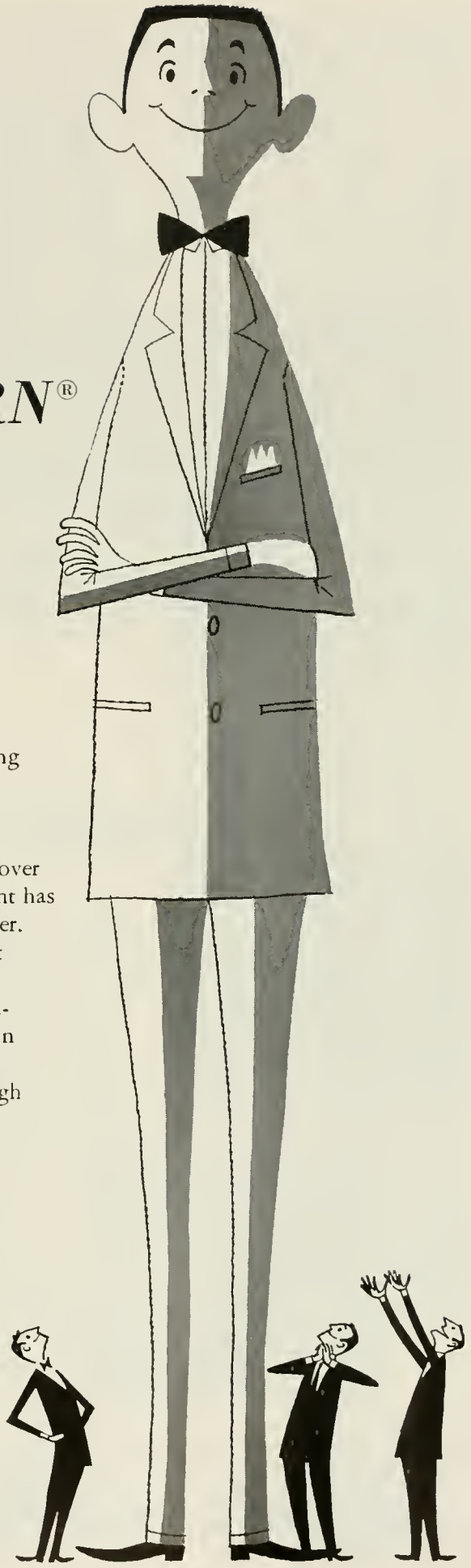
For further information, write now, Dept. P at our Pittsburgh address or any of the plants.



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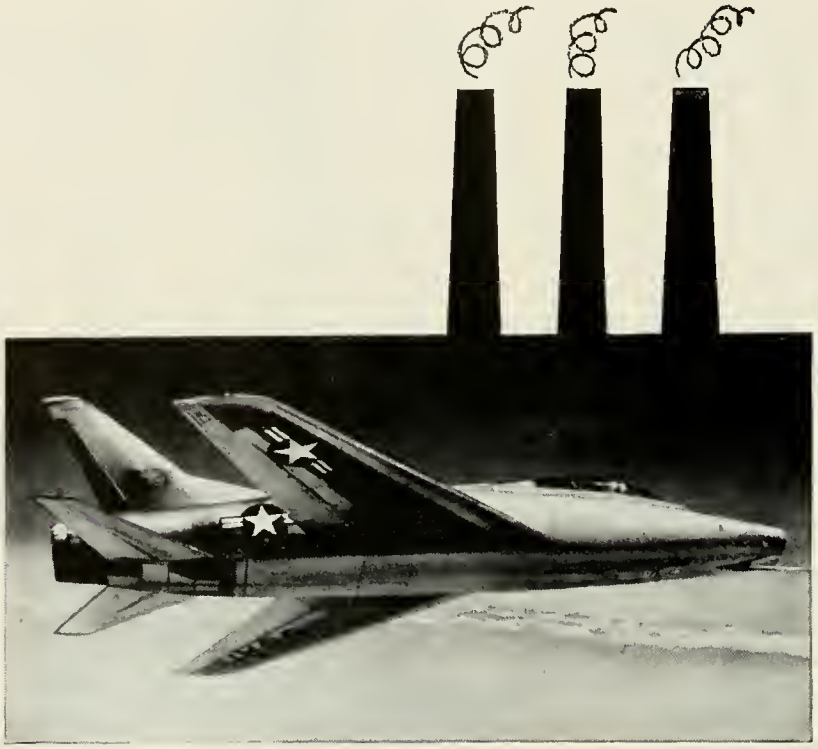

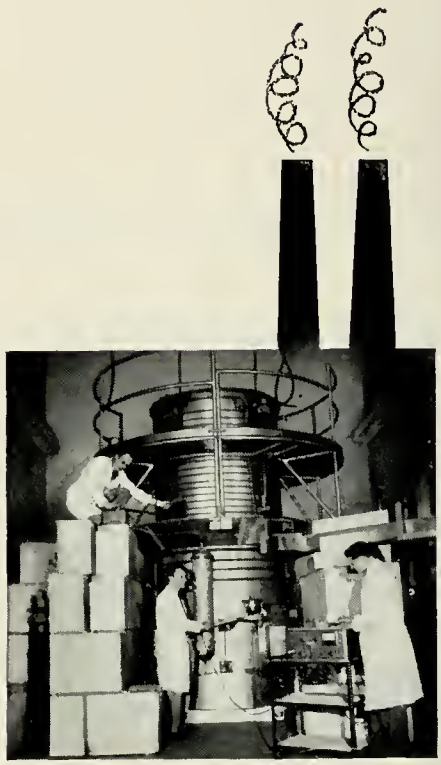

DIVERSITY CREATES OPPORTUNITY

Although best known for design and production of world-famous aircraft like the Korea-famed F-86 *Sabre* Jet and the new, record-smashing F-100 *Super Sabre* . . . North American Aviation also offers engineers excellent opportunities in other technical fields.

North American needs engineers with imagination to help design and build the aircraft of the future. Other fascinating careers are created daily in its rapidly developing guided missile, jet, propulsion systems, electronic and atomic energy programs.

When you are ready to enter the engineering profession, consider the well-paid opportunities at North American. Meanwhile, write for information on your future in the aircraft industry.

Contact: **Your College placement office or write:**

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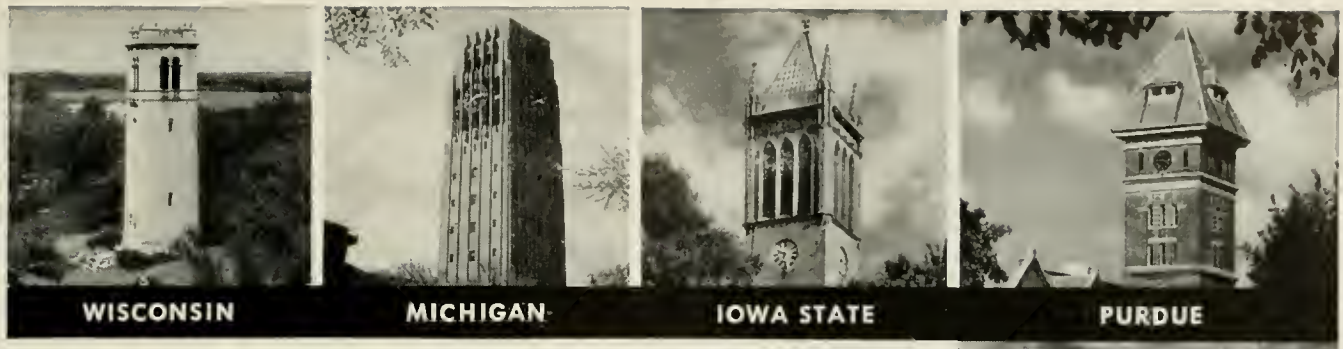
ENGINEERING AHEAD FOR A BETTER TOMORROW

NORTH AMERICAN AVIATION, INC.



these NINE schools produce FINE engineers!

We know—because, over a period of years, many of them have come with Square D, direct from these nine schools. The vast majority are still with us—growing and prospering in the constantly expanding electrical field.

This year and every year we'll be visiting these same nine schools—looking for additional electrical, mechanical, industrial and general engineering talent. We'll interview hundreds of men to get a dozen. The standards are high—the opportunities great. Why not let us tell you more about Square D and what we have to offer?

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We'd like to send you a brochure, "Your Engineering Career." It gives the simple rules to follow in selecting an engineering career.

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Industrial Research Reactor

The first nuclear reactor for industrial research will be established at Armour Research Foundation of Illinois Institute of Technology, Chicago, it was disclosed today by Dr. Haldon A. Leedy, Foundation director.

By offering direct benefits to industry through a new research tool, the proposed reactor promises to be a major advance in the technology of the Chicago area. Plans for the reactor — or "atomic pile" — are being submitted to the Atomic Energy Commission for consideration of the design, building plans, and schedule of operation.

Chicago area industries will join the Foundation in financing the reactor and associated equipment, which will cost approximately $500,000. The reactor will be housed in a new 8,000-square foot building on the Illinois Tech campus.

The proposed reactor, designed for 50,000 watts, is specifically a highly flexible neutron and gamma source, and is not intended for research on reactors themselves or for the generation of electrical power, according to Dr. Richard F. Humphreys, manager of the physics research department, who is director of the project.

The reactor will permit investigations into such fields are: sterilization of foods and drugs; high polymer studies of the structure of plastics, rubber and similar materials; glass and ceramics; wear and friction studies; the development of metals and alloys, and medical techniques for diagnosis and therapy.

At present, there is only one reactor not devoted to AEC work—a 10,000-watt reactor at North Carolina State college. At least three more are being planned for educational and college research, but the Armour Research Foundation reactor is the first directed toward industrial research.

Surrounded by 2,500 square feet of working area to accommodate experimental set-ups, the reactor will possess a maximum of ports and a large thermal column for convenience in irradiation and other uses.

The reactor room will be a gas-tight steel tank, approximately 60 feet in diameter, and 25 feet high. It will be adjacent to laboratories for handling and storing radioactive material and for conducting nuclear research.

Sponsored reasearch will be subject to no security classification, no competition from military applications, no secrecy of any kind other than that called for in the protection of the individual sponsor's programs.

Fuel for the reactor will be obtained from the Atomic Energy Commission on "extended loan," as required by law. The fuel will be granted only after careful inspection by the AEC.

Armour Research Foundation will assume about one-third of the investment. Industries in the Chicago area are being invited to participate in the construction of the facility with subscriptions of $20,000, for which they will receive a number of benefits.

The reactor will make possible:

1. Production of short-lived radioisotopes that would be impractical to procure from distant government laboratories such as Oak Ridge.
2. Neutron activation, a new and powerful technique used for the most sensitive chemical analysis known. By this method, wear studies, nondestructive testing, and other difficult studies now become possible.
3. Neutron diffraction for use in structure analysis that exceeds standard x-ray techniques.
4. Radiation-induced effects in plastics, glasses, organic systems, and certain metallic alloys.
5. Studies on the effects of radiation on biological and chemical systems.

An extensive research program will be conducted by the Foundation on problems of specific interest to the participating industries. Results of this research, including any inventions that may arise, will be made available to the participators.

Power Transistor

A combination of mounting and physical design has made possible the one-watt rating of this new germanium power transistor, now in pilot production by the Westinghouse Electronic Tube Division. The black, ribbed surface provides cooling capacity for the one-watt collector dissipation rating. Additional cooling is accomplished by fastening the unit in thermal contact with the chassis as shown.

The new pnp-type transistor (2N71) will be applicable to any low-frequency circuit, such as class A amplifiers, where output power is desired.

A young school teacher said to her best student, aged seven, "Tommy, if I lay one egg on the table and two on the chair, how many will I have altogether?" "Personally," answered Tommy, "I don't think you can do it."

* * *

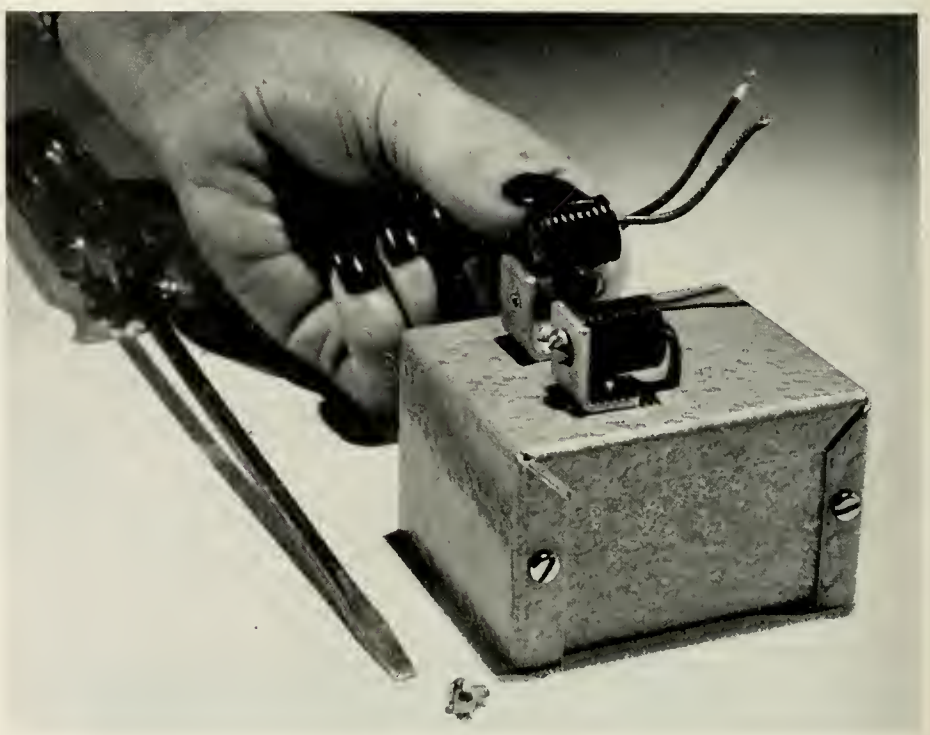
"Miss Jones," said the science professor, "would you care to tell the class what happens when a body is immersed in water?" "Sure," said Miss Jones, "the telephone rings."

* * *

A bachelor skunk visited a newly married pair of skunks and was surprised to find an extra bed in their room. When questioned, they explained, "We are expecting a little stinker in the spring."

* * *

The English barmaid was a flirtatious piece, and the tall, sunburned Texan private was right down her alley. The MP had left the bar for a moment, and the barmaid cuddled up to the Texan, and murmurred, "Here's your chance, big boy." "You said it," agreed the private enthusiastically—and drank the MP's beer.



New one watt pnp type Germanium power transistor

Search is exciting!

Scientists are constantly probing deeper into the secrets of nature —bringing new and better things to you

AS THE PROSPECTOR thrills to the search for treasure, so does the scientist as he searches out the secrets of the earth, air, and water.

THE TREASURE that the scientist seeks is better understanding of nature, and ways to bring better living for all of us. To find them, he is constantly probing, taking the elements apart, putting them back together in different ways—always looking for something new and promising.

How important is such research? Today, more than one-third of the work of the people of Union Carbide is in providing products and processes that did not exist in commercial quantities 15 years ago. Each new product, each new process, was born of intensive search.

FROM CHEMICALS TO METALS—The results of these achievements are serving all of us today—chemicals for life-saving medicines and many other uses...a wide range of carbon and graphite products . . . oxygen for the sickroom and industry . . . a variety of wonderful new plastics . . . alloying metals for stainless and other fine steels.

SEARCH . . . RESEARCH? To the scientists of Union Carbide, search and research are the same—an exciting key to a brighter future for all.

STUDENTS AND STUDENT ADVISERS: *Learn more about career opportunities with Union Carbide in* ALLOYS, CARBONS, CHEMICALS, GASES *and* PLASTICS. *Write for booklet M-2.*

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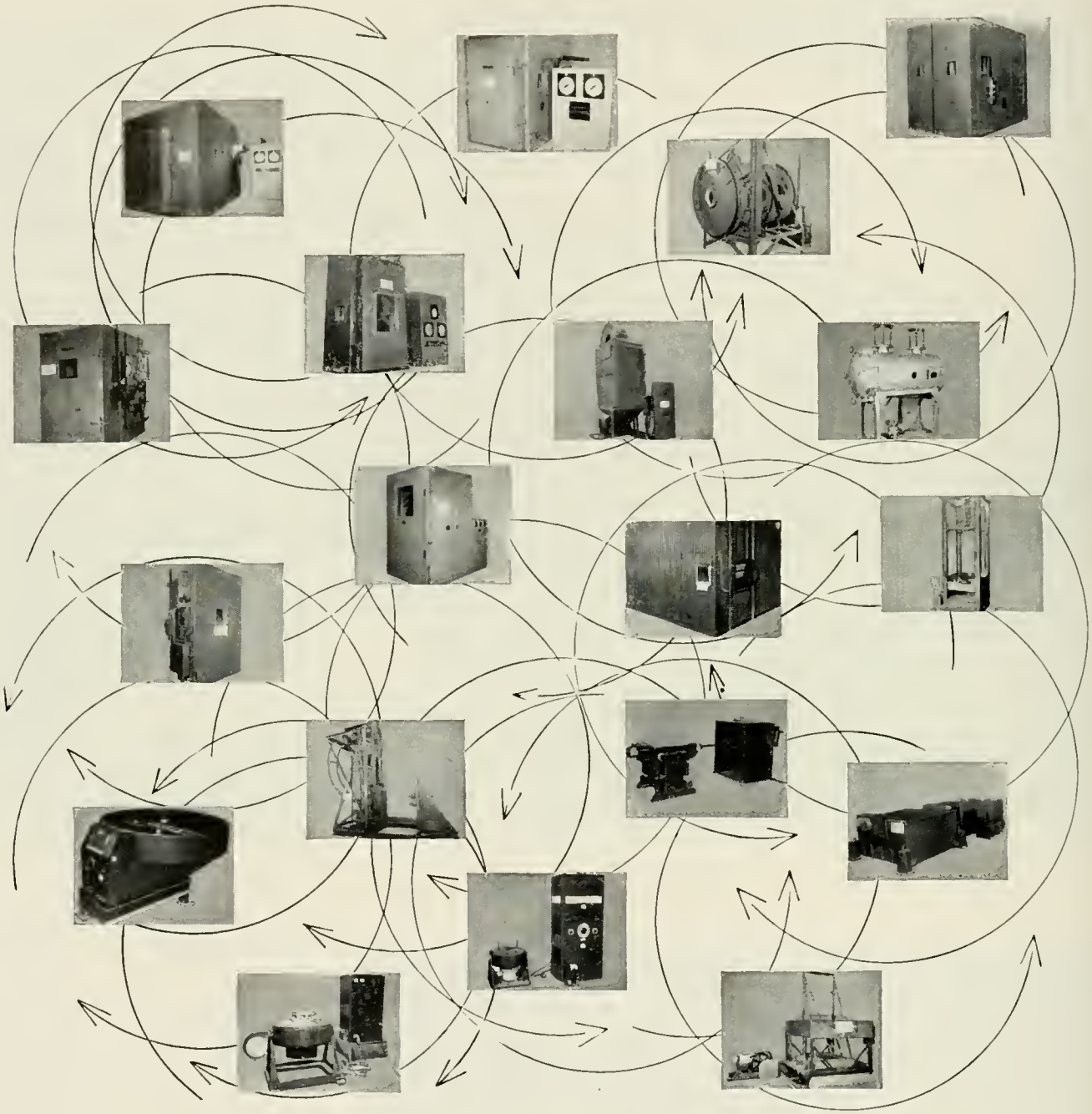


19 chambers of hell

You are looking at the units of a $2,000,000 Martin testing laboratory—part of a man-made hell of fire and water, shock and vibration, explosion and corrosion, designed to torture *electronics equipment!*

For these vital components of today's aircraft, guided missiles and weapons systems must carry tremendous responsibilities. Consider, for example, the electronic system of the Martin B-61 Matador:

Incredibly versatile, it comprises the entire brain and nervous system of America's first successful pilotless bomber. Yet this sensitive equipment must withstand the shock of many tons of thrust in the first second of take-off—violent changes in temperature and pressure—and ground conditions ranging from sand storms to arctic blizzards, desert dryness to tropical downpour.

Today, Martin's facilities are among the finest in the world for design, production and proving in the field of avionics...one of the major developments of Martin Systems Engineering which is now tailoring airpower to previously impossible requirements.

You will hear more about Martin!

MARTIN

BALTIMORE · MARYLAND

Another page for **YOUR BEARING NOTEBOOK**

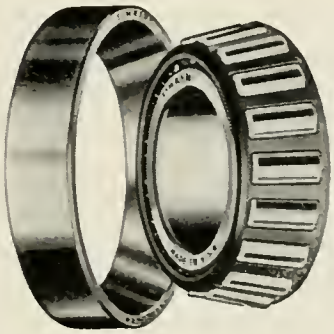
How to beat shock loads in a big dragline

Imagine the shock loads put on this big dragline's intermediate swing shaft when the cab, the boom and an 8-yard load of dirt being swung through the air are suddenly stopped and the direction reversed! Engineers solved this problem by specifying Timken® tapered roller bearings. Timken bearings not only take radial and thrust loads in any combination, they also assure long, trouble-free operation.

Why TIMKEN® bearings have high load capacity

This cross section of a Timken tapered roller bearing illustrates one reason why Timken bearings do such a good job under heavy load conditions. Notice that there is full line contact between the rollers and races. It's this full line contact that distributes the load over a wider area, gives Timken bearings their extra load-carrying capacity.

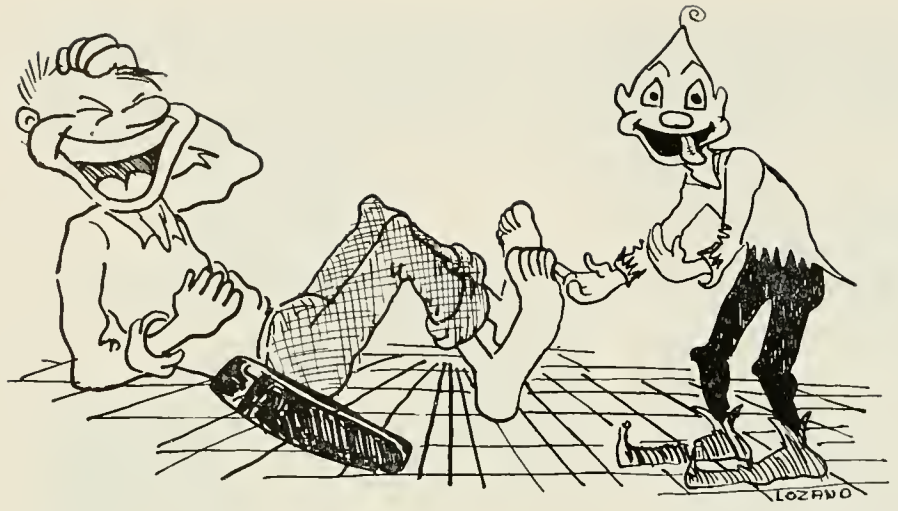
TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS



Want to learn more about bearings or job opportunities?

Some of the engineering problems you'll face after graduation will involve bearing applications. For help in learning more about bearings, write for the 270-page General Information Manual on Timken bearings. And for information about the excellent job opportunities at the Timken Company, write for a copy of "This Is Timken". The Timken Roller Bearing Company, Canton 6, Ohio.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭
BEARING TAKES RADIAL ⦶ AND THRUST —⦶— LOADS OR ANY COMBINATION ✳



TECHNOCRACKS

"I don't get it," said one pretty girl as she divested herself of her undergarments. "I tell the doctor my sinus is bothering me and he asks me to strip." A naked redhead with a satchel on her lap replied, "My case is even more puzzling. I'm here to tune the piano."

* * *

Then there is the story of moron answering the telephone. "What is it?" asked the moron. "It's a Long Distance from New York," replied the operator. "I know it is," said the moron, and he hung up.

* * *

A chemistry professor chalked a formula HNO_3, on the blackboard. Then he wheeled about and pointed a finger at the sleepiest member of the class. "Identify that formula," he demanded

"Er, ah," stalled the unhappy student, "I've got it right on the tip of my tongue, sir."

"In that case," said the professor softly, "you'd better spit it out my boy. It's nitric acid."

* * *

Then there is the story about when Calvin Coolidge was in the Massachusetts legislature, another member asked him whether the people where he came from said, A hen lays, or a hen lies."

"The people where I come from," replied Mr. Coolidge, "lift her up to see."

* * *

A Scotsman leaned against a midtown bar holding his stomach and moaning piteously. "Sick?" asked the sympathetic stranger who stood next to him.

"Verra, verra sick," said the Scotsman. "I am afraid I've got yoors."

"What's 'yoors'?" asked the stranger.

The Scotsman brightened immediately. "Make it a scotch and soda," he said.

Two veterans of World War One met in Baltimore. "Remember that saltpeter they used to put into our food in Camp Lee in 1918?" asked one. "I sure do," said the other. "It's starting to take effect now," mourned the first.

* * *

There once was a young lady named
Maude
A sort of society fraud.
In the parlor, tis told
She was distant and cold
But on the veranda, my Gawd.

or

Little Willie wrote a book
Woman was the theme he took.
Woman was his only text.
Aint he cute? He's oversexed.

or

Said an ape as he swung by his tail
to his children, both female and male.
"From your offspring, my dears,
In a couple of years,
May evolve a professor at Yale."

* * *

Billy (the college man): What are you doing wearing that I sweater? Don't you know that you wear it only when you have made the team.

Milly (soft spoken college girl):—Well?

* * *

That reminds me of the story of the little boy who had just gotten a pen friend from Holland. He was so happy about it, that when he came home that night he said cheerfully, "Guess what Mom? I got a girl in Dutch."

* * *

A sign in front of a shoe repair shop pictured styles of rubber heels and a beautiful girl who was saying. "I'm in love with America's number one heel." Underneath in small feminine headwriting someone had added, "Too bad sister, I married him first."

A bouncer in a Bowery saloon threw a free-lunch moocher out on his ear four times running, but the undaunted victim kept staggering back for more. A customer watched the performance with unflagging interest, and finally tapped the bouncer on the shoulder: "Know why that bum keeps coming back in?" he observed. "You're putting too much back spin on him."

* * *

She: I saw a Texas Ranger carrying two rifles.

He: That's nothing. I saw a cowgirl packing a pair of 38s.

* * *

Here is one about a venerable psychotic patient on Welfare Island who spends her entire time reading the Bible. She explains, "I'm cramming for the finals."

* * *

A young engineer was out teaching his younger wife to drive, when suddenly the brakes failed. "What shall I do?" screamed his wife. "Brace yourself," he said, "and try to hit something cheap."

* * *

Two young coeds met for lunch during the last vacation: They hashed over clothes for a while until the topic came around to marriage. "I hear that your boyfriend graduates from law school this June. I guess you will get married then." "Oh no," replied her friend, "I want him to practice for about a year first."

* * *

A dog and a cat became embroiled in a street corner fight, and a big crowd gathered to watch. One unruly spectator suddenly whipped a gun out of his pocket and shot the dog. A policeman heard the report and came running on the double. The killer threw his gun to the ground and appealed to the crowd. "Don't say a word to the cop. He'll think the cat did it.

* * *

She: I nearly fainted when the fellow I was out with last night asked me for a kiss.

He: Baby, you are gonna die when you hear what I have to say.

* * *

"Now, boys," said the Sunday School teacher, "if we are good while on earth, when we die we will go to a place of everlasting bliss. But suppose we are bad what will become of us?"

"We'll go to the place of everlasting blisters," answered a small boy at the bottom of the class.

* * *

Once a young college femme wrote the editor of a correspondence column, "I am only 19 and I stayed out till two the other night. My mother objects. Did I do wrong?"

The answer published in the paper next day: "Try to remember."

Westbound Rio Grande freight in Ruby Canyon of Colorado River.

The freight rolls away an hour sooner

because photography cuts yard bookkeeping

The Denver and Rio Grande Western Railroad microfilms its waybills in minutes, cuts running schedules, saves costs in train idling time.

You don't find a Rio Grande freight idling at the terminal while waybills are copied by hand. Instead, Recordak Microfilming copies them. Then they're put aboard and the train is off in just about one-fifth the time it used to take, thus saving hours of valuable crew and train time. Then the wheel reports are made up from the films and teletyped ahead.

Railroading is but one of over a hundred types of businesses now saving money, time and space with microfilming. It is one of the fast growing and widely used ways photography works for industry.

Small businesses and large are finding that photography helps in simplifying routine procedures, in product design, in personnel relations. It improves production, saves time and cuts costs.

Graduates in the physical sciences and in engineering find photography an increasingly valuable tool in their new occupations. Its expanding use has also created many challenging opportunities at Kodak, especially in the development of large-scale chemical processes and the design of complex precision mechanical-electronic equipment. Whether you are a recent graduate or a qualified returning service man, if you are interested in these opportunities, write to Business & Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N.Y.

Eastman Kodak Company, Rochester 4, N.Y.

CHARLES SNYDER, R.P.I., (center) adjusting 5250 triple-unit d-c mill motor for use in a steel mill.

Engineers RICHARD RENK, IOWA STATE, (left) and ALLEN FRINK, CATHOLIC UNIV., make last-minute check on 1600-hp diesel-electric switcher before it is moved to test track.

THEY'RE "GOING PLACES" AT GENERAL ELECTRIC

Like these young men pictured here, hundreds of scientists, engineers, chemists, physicists and other college graduates are "getting ahead" fast at General Electric . . . . and they are working on projects with the assurance that their contributions are meaningful and important.

They are moving up rapidly because at General Electric a world of opportunity awaits the college man of today—a world limited only by his own ability and interest. The variety of General Electric products and the diversity of the Company's operations provide virtually unlimited fields of opportunity and corresponding rewards, both materially and in terms of personal satisfaction to young men who begin a G-E career.

New developments—in silicones, electronics, semi-conductors, gas turbines, atomic power, and others—springing from G-E research and engineering, are creating exciting new opportunities, and are giving college graduates the chance of finding satisfying, rewarding work.

And by placing prime importance on the development of talent and skill, developed through G-E training programs and broadened through rotational job programs, and by providing incentives for creative minds, General Electric is hurrying young men into success in an industry that is devoted to serving all men through the ever-increasing and ever-widening uses for electricity, man's greatest servant.

If you are interested in building a career with General Electric see your college placement director for the date of the next visit of the General Electric representative on your campus. Meanwhile, for further information on opportunities with General Electric write to College Editor, Dept. 2-123, General Electric Company, Schenectady 5, New York.

Test engineers E. K. VON FANGE, U. OF NEB., (left) and R. E. LOVE, U. OF TEXAS, work on stacker and stapler built by them for homework project.

Physicist ROGER DEWES, BROOKLYN POLY., working with scintillation counter in G.E.'s Engineering Laboratory.

ANTHONY TERZANO, PRATT INSTITUTE, checks connections on direct-current rectifier which charges 7,500,000-volt impulse generator in G.E.'s new High-voltage Laboratory.

GENERAL ELECTRIC

Chemistry Library
Noyes Laboratory
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February, 1955

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ILLINOIS TECHNOGRAPH

Sanford W. Wilson, class of '48

speaks from experience when he says . . .

"U. S. Steel offers a great combination—opportunity, security and an interesting job"

MR. WILSON was interviewed by U.S. Steel representatives in March of 1948. After receiving his B.S. in Chemical Engineering in June, he chose his U.S. Steel offer over several other job offers and began working at the huge Gary Works as a Foreman Relief Trainee. He gained experience in the Blast Furnace Department and in the front office learning the business end as well. In November of 1954 Mr. Wilson was made assistant to the superintendent of blast furnaces at Gary. His duties now include developing data for control of production, quality of materials, costs, and making technical reports. In addition, he directs the activities of Technological Co-Ordinators and part of the training of management trainees.

Mr. Wilson is naturally pleased with his progress at U.S. Steel and he feels that U.S. Steel offers qualified and ambitious engineers the very best in three important areas—opportunity, security *and* an interesting job.

He says, "Opportunity is unlimited at U.S. Steel and openings for advancement are frequent." In addition, Mr. Wilson feels that U.S. Steel affords a secure future because of the basic nature of the steel industry and the constant need for engineering talent. But most important, Mr. Wilson is deeply interested in his job because he knows he is really playing a vital role in a vital business. And he says, "The steel industry has many facets and is constantly changing. Talk to anyone who has been in the steel industry for any time and he will tell you that steel has gotten into his blood."

If you are interested in a challenging and rewarding career with United States Steel and feel that you can qualify, you can obtain further information from your college placement director. Or we will gladly send you our informative booklet, "Paths of Opportunity," upon request. Just write to United States Steel Corporation, Personnel Division, Room 1622, 525 William Penn Place, Pittsburgh 30, Pa.

SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

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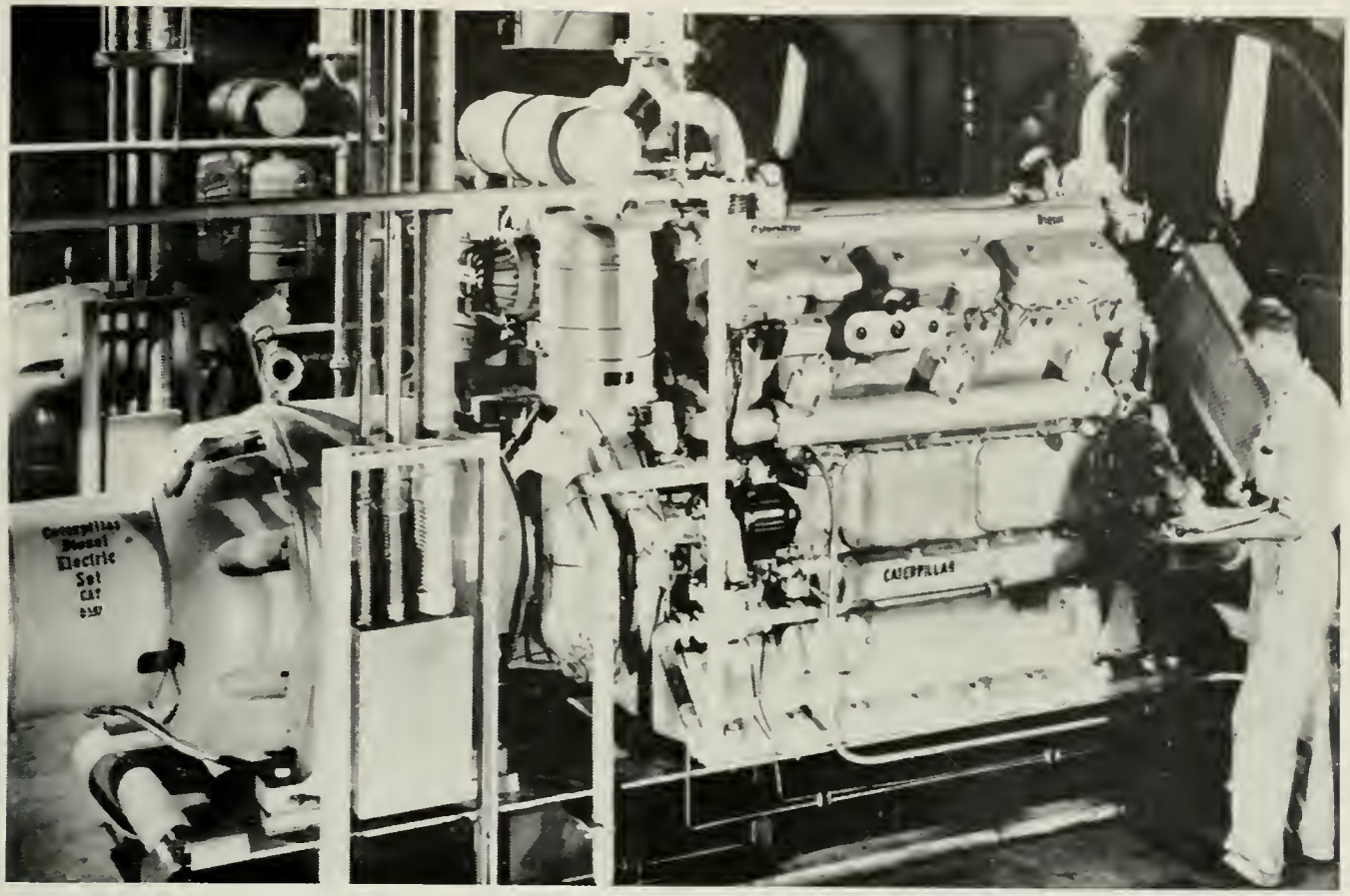

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Caterpillar Tractor Co. is growing. There's a need for young men with training and vision: Mechanical, Metallurgical, Agricultural, Electrical, Civil Engineers and others. You'll be doing an important and challenging job at Caterpillar: in research and development, design, manufacturing, sales, or your choice of many other fields. You'll have the best in laboratory facilities and really interesting assignments at Caterpillar plants and in the field.

And you'll be able to grow—solidly and steadily, along with us. Promotions at Caterpillar come when they're earned, and executive positions are filled from within the organization. You'll find good starting pay and good housing conditions.

There's a place for you on the "Big Yellow Team." Representatives of Caterpillar Tractor Co. will be on campus for interviews. Consult your placement office. Meanwhile, if you would like more information, write to Caterpillar Tractor Co., Employee Relations General Office, Box IL-3, Peoria, Illinois.

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NEW MISSILE SYSTEMS RESEARCH LABORATORY

The technology of guided missiles poses increasingly complex problems in virtually every field of science.

To provide physicists and engineers with the most modern facilities for meeting those problems, Lockheed Missile Systems Division has begun construction on a laboratory for advanced research—first step in a $10,000,000 research laboratory program.

Scheduled for occupation in early fall of 1955, it will augment existing Missile Systems Division facilities.

Individuals able to make significant contributions to the technology of guided missiles are invited to contact their placement officer or write us.

Lockheed MISSILE SYSTEMS DIVISION

research and engineering staff

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Looking ahead *and building* with Detroit Edison

Important new addition to the engineering facilities of Detroit Edison is this huge System Analog and Network Computer, bringing new speed, accuracy and convenience to solving the problems of providing better power systems, both for today and for tomorrow.

Designed and built by Detroit Edison engineers, this unique four-ton machine reproduces in miniature the company's power system, and can be varied to simulate other power systems as well. The effect of any combination of generators, transformers, lines, cables and other equipment, and of any variations in components within the system, can be determined in a fraction of the time required by conventional methods.

The System Analog and Network Computer, along with other advanced electronic equipment, such as the digital computer, serves Detroit Edison engineers in a variety of fields, including research, system operation, and production, planning, project and design engineering. . . . Such advanced facilities, combined with the steadily rising demands for electrical power in Detroit and Southeastern Michigan, enable Detroit Edison to offer young engineers an outstanding opportunity and challenge to build for their own futures.

For the full story of career opportunities at Detroit Edison, simply call or write for a free copy of this new booklet, "Detroit Edison Engineering."

THE DETROIT EDISON COMPANY
2000 Second Avenue
Detroit 26, Michigan

Take A Giant Step...

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There's little doubt about the fact that rubbing shoulders with success, early in your career, is one of the best ways to assure your own long-range success.

You'll find this especially true at Sylvania, where, in one company, so many of the positive factors essential to *engineering achievement* are combined in full measure:

DIVERSITY— Sylvania's 9 divisions developing and manufacturing products ranging from television sets to fluorescent lamps, from electronic devices to fuel elements for nucleor reactors, provide the breadth of experience to help direct you into the work you most prefer in our organization.

GROWTH AND EXPANSION — In the past 6 years alone, our sales *have tripled*, our engineering staff *has doubled* to keep pace with the demand for Sylvania products. And, we are expanding our activities in the field of atomic energy and new areas of electronics.

STABILITY — Founded in 1901, Sylvania has grown into an organization of 45 plants and 11 laboratories in 11 states. In addition to the development and manufacture of our own Sylvania consumer products, we are also privileged to provide elements and parts that are the heart of hundreds of industrial and consumer products of other manufacturers, which adds to our characteristic stability.

An aggressive, forward-looking company with all the drive and vigor of youth . . . whose average executive age is only 45 . . . Sylvania can provide the environment of success and encouragement that will help you build a highly satisfying professional future.

For detailed information, see your College Placement Office, or send for our comprehensive brochure, "Today and Tomorrow with Sylvania," by writing to Supervisor of Technical Employment.

SYLVANIA

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LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

A Guide to Job Seekers . . .

In these years of great demand for engineers, the student has a great advantage when the interviewers come to the campus. This, naturally, should not give him the feeling that he deserves it or can abuse it. He should be courteous, considerate, and business like in his approach to the representatives of the company he wishes to sell his services to.

In a recent bulletin issued by the N.E.M.A. a code of ethics for interviewing procedures was presented. The following were considered responsibilities of the student being interviewed:

1. In anticipation of an interview with an organization, it must be the responsibility of the student to prepare himself properly by reading literature, attend meetings at which the story of that industry is being presented, organizing his own thoughts in order to ask and answer questions, and being as fully informed as possible on the type of business conducted by that organization.

2. He should be prompt in meeting interviewers and in handling his correspondence.

3. He should not accept interviews after he has signed up with a company.

4. After accepting an offer, he should promptly notify those companies whose offers are to be rejected.

5. He should use care in filling out various necessary forms.

6. He should recognize that failure to answer offers of employment is detrimental to his classmates, and therefore, he should be prepared to make his decision far enough in advance of his graduation so that industry can make its plans.

7. He should keep the placement office or faculty members intimately advised concerning his negotiations.

8. He should recognize that regardless of the number of interviews he takes he should conduct himself in a business like manner and not expect individual or unusual consideration or entertainment.

9. He must recognize that he must sell himself and that industry can advance him only on the basis of his performance.

D.F.K.

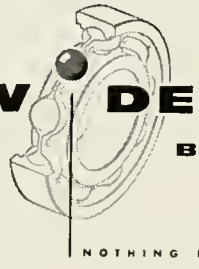
WHAT HATH MARCONI WROUGHT?

Of course, it was years before Mr. Marconi's wireless developed into radio as we know it. Then such wonders as the give-away program, the comedy show and the soap opera blossomed full-blown.

True wonders, too, have sprung from Mr. Marconi's "new departure" of 1897. And New Departure ball bearings have played a vital role . . . in electronic brains for business . . . in automation for industry . . . in radar for defense. In fact, New Departure was a pioneer in developing methods that could turn out ball bearings of ultra-high precision in the mass quantities needed for today's electronic marvels.

Such leadership is one of many reasons why engineers look to New Departure for the *finest* in ball bearings!

The amazing Skysweeper — which sights, tracks and shoots down air targets with fantastic accuracy — depends on New Departure instrument ball bearings for its internal accuracy.



NEW DEPARTURE
BALL BEARINGS

NOTHING ROLLS LIKE A BALL

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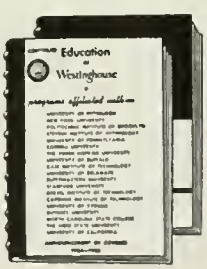

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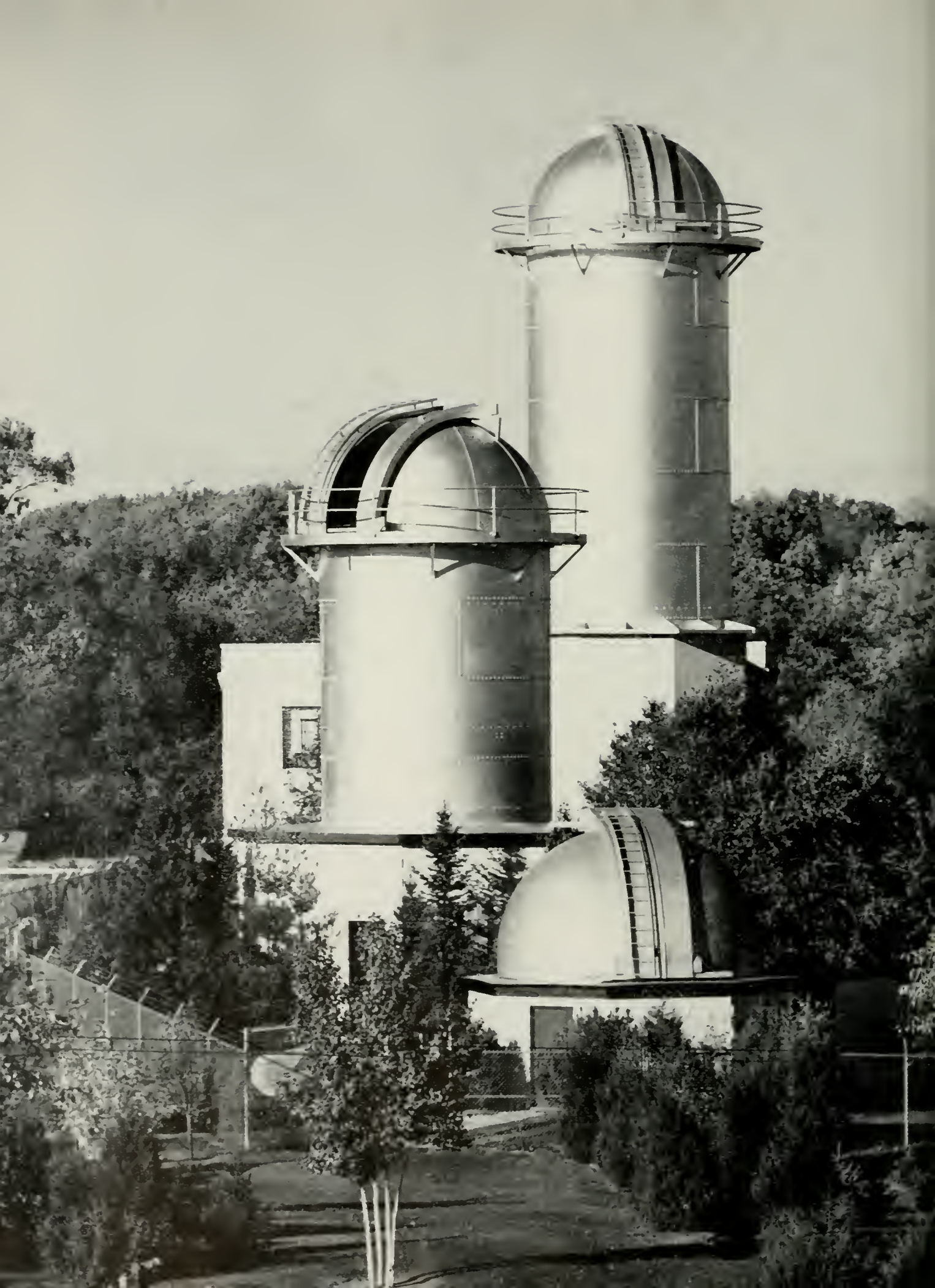
our cover

Even in the remotest part of the world, man cannot help but feel the influence of modern engineering. The man who said "There is nothing left to invent," didn't realize that there is a challenge in everything, even in shipping these logs to the mill. (Cover courtesy Hamilton Standard)

our frontispiece

The McMath Hulbert Observatory of the University of Michigan. The smallest dome, in the foreground, houses a 24 inch Cossegrain reflector. The tower and dome in the middle ground holds instruments which photograph solor feotures. Solar spectographs are housed in the remaining structures.



A Look at the Sun

by Jim Piechocki, Aero E. '56

(This paper is written chiefly to bring to light and clarify the various aspects of solar activities and effects, which seem to be so vaguely understood by everyday man. Very few people realize the great effect that the sun has on our lives. If the reader can be led to appreciate the vast amount of unheralded study that this huge glob of atomic incandescence has prompted, he will perhaps alted his dim view of that fiery object which does more than merely brighten our days and "make things grow.")

Next to the moon and birds, the most accepted object in the sky is the sun. And why not? After all, we generally do see or feel the presence of the sun for more than eight hours a day, and such things as clothing on the lines, green grass, and suntans are commonplace. But only the inquisitive mind discovers the marvellous significance of the sun. It will be a searching mind which will discover new ways to utilize the sun's power.

What did ancient man think of the sun? He worshipped it as a god long before the history of his religion began. As the days grew colder and the sun spent a shorter period of time in the sky, who could say that warmth would return and shadows would grow shorter again? Primitive man fell to his knees and pleaded for the return of warmth. Perhaps prayer and sacrifice would make the sun god merciful, they thought. This idea of a solar diety was shared by the ancient Egyptians, Persians, and Western Hemisphere tribes, to mention a few. However, as early as 1450 B. C. men began to rebel at this form of worship. The first known rebel was the young Egyptian, Amenhotep IV, a remarkable individual with powers of abstract reasoning taht were thousands of years ahead of his time. He became a tolerant king, but all memory of him, even three thousand years after his death was evil. He was called a fanatic and a persecutor because he dared to change a time-honored form of devotion.

Sunworship seems to have made an important contribution to astronomy. While looking upon the sun for hours at a time, men were led to certain questions. Where did the sun god come from? How does he furnish his burning light and heat? And how far is he from this world? The Greeks, who loved knowledge for the sake of knowledge, began poking their noses into the question of the distance that stretched between the sun and th emoon. From observation they knew that both bodies appeared to be of equal diameter. But during eclipses of the sun, the moon always passed in front of the former. Hence the sun had to be the farther body. About 270 B.C., Aristarchus made an ingenious approach to the problem. He reasoned that at first and last quarter lunar phases, the angle at the moon between the earth and the sun was a right angle. If he could measure the angle subtended at the earth at that same time, he could calculate not only their relative distances, but also their relative sizes. Because of his observational techniques, a slight error on his part (he had picked a difficult thing to measure) resulted in a gigantic error in the final answer. His figures placed the sun twenty times farther from the earth than the moon—an error of 2000 per cent. But as time passed and concepts of the universe changed, more accurate measurements were demanded. In 1672, a reasonably accurate measurement of this distance was made by triangulation with Mars in opposition with the sun, while the best measurements were made in the eighteenth and nineteenth century Here the planet Venus' transit across the face of the sun was utilized along with a few minor bodies, including Eros, a minute planetoid that comes closer to the earth than any body except the moon. Thus, the mean value of 93,000,000 miles was arrived at and has become a standard distance to astronomers—one astronomical unit, or one a.u. Hence it can be seen that the ancient scientists, as wrong as they were, laid the foundation for later techniques.

Convair's 120 inch solar furnace, which focuses the sun's rays to a dime-sized point. Temperatures up to 8500° F have been reached.

But before getting into a detailed discussion of solar measurements and techniques, let's look at a problem which baffled early astronomers—the origin of the sun.

The question of the origin of the sun brings us to a problem which caused a great deal of scientific stimulation in the nineteenth century, namely, that of the origin of the solar system. An early theory envisioned a huge ball of swirling hot gases struck by another great body which carried away a torrent of matter. This material eventually coalesced far off into globes of different magnitudes and at different distances from the original mass. (Some astronomers even went so far as to name the wayward star as 46 Tauri, a faint body in the constellation of the Bull.) The newly formed bodies cooled, solidified, and assumed spherical shapes. They were then held in their orbits by the now smaller and battered sun. This is the essence of the so-called planetesimal theory.

The great French mathematician, Laplace, also proposed a theory concerning the origin of the solar system. In his nebular hypothesis, he proposed that a huge gaseous nebula began a gradual shrinking and swift rotation. Contraction of the central part formed a sun and fast rotation of the outer portions, eventually solidfying into planets, kept them from being drawn into the center. The lack of evidence of any circular motion of gaseous nebulae as observed today tends to weaken this theory.

The latest attempt at an explanation of the sun's origin is embodied in the accretion theory. The theory proposes that stray atoms floating about in the interstellar void collided with cosmic dust particles to form a new and larger mass. Since the atom is much smaller than the cosmic particle it strikes—the former are approximately 1/50,000 of a centimeter in diameter—it adheres to the latter, actually "freezing" in place. This process continued for ages, and with the mass increasing in size, pressures and temperatures of decomposition increased. A sun was then formed.

The three theories mentioned are the fundamental ones. There are many more. Today, the best theory for the origin of the solar system is a recent modification of Laplace's nebular hypothesis.

We are now ready to consider a few basic physical characteristics of our sun. First of all, it is merely an ordinary star, that is, it produces its own light. It is average-sized as stars go, and we can be downright proud of it in relation to the faintest stars, as it would take 500,000 of the universe's weakest to give the same amount of light as our own. Yet there is one observed star in the Large Magellanic Cloud which emits light of intensities 500,000 times that of our sun. The origin and extent of our sun's heat and power will be discussed later. The diameter of the sun is 864,000 miles, or about 110 times that of the earth. Its mass is 2.2×10^{27} tons, or 333,400 times the earth's mass. If the earth and its moon were placed inside the sun and at the latter's center, the moon while revolving in its orbit would still have about 200,000 miles clearance from the surface of the sun. The mean density of the sun is 1.4 times that of water, and yet it is entirely gaseous. This fact suggests that the mass of the sun is being subjected to unimaginably high pressures. Structurally speaking, the sun has been divided into separate layers for practical reasons. The visible surface, called the photosphere, or light sphere, is the source of the light and heat. When viewed through special telescopes it has a granular appearance and is constantly shifting and changing. Sunspots are observed here also. Flares or bright gases associated with spots, and irregular clouds, called faculae, occur on the photosphere. Gases near the top of faculae are less dense than the surroundings, hence they permit an observer to peer farther down into the hot surface than under normal conditions. By means of a special device known as a spectrohelioscope, which permits the use of light of only one common element at a time, other clouds, both bright and dark, can be seen. Distinct bright regions observed in this manner are called flocculi. Gigantic clouds of calcium and hydrogen are common.

The birth of an eruptive prominence, with hot gases traveling at 600 miles per second.

The photosphere is surrounded by the solar atmosphere which is also broken up into separate layers for purposes of study. First comes the reversing layer, a relatively thing region directly above the light sphere. It is the densest part of the sun's atmosphere. Due to the intense light from the photosphere, the reversing layer is invisible and can be seen only with the aid of a special device which blots out the photosphere. This instrument is called the spectroheliograph and when used permits the reversing layer to be photographed as a bright red ring. This color is due primarily to radiation from hot hydrogen vapors. The spectroheliograph also permits the study of solar prominences, fantastic eruptions from the photosphere which shoot up thousands of miles above the sun's surface. The region immediately above the reversing layer is called the corona and is somewhat brighter and hotter than the former. The reason for this heat difference is still a mystery and many theories hoping to explain the temperature rise in the corona have been presented and discarded. The corona cannot be observed under ordinary conditions. Until certain instruments were perfected, astronomers had to wait for a total solar eclipse to cut off all direct sunlight and thus allow the corona to be photographed. It has been estimated that the chances of a total solar eclipse to occur in any one place on the earth are one in 360 years. But with the perfection of the coronagraph, a device which artificially blots out the main disk, the corona could be seen in all its pearly-white glory on any clear day. When seen from the earth, it appears as a flaming haze spreading out a distance of about one solar diameter from the sun's surface. It is even more spectacular when viewed at a time of sunspot maximum activity. At such times streamers are seen extending a distance of 10,000 miles into space in a fanwise array. Such a display was seen during the total solar eclipse of May 28, 1900, and January 14, 1926. The nature of the corona is not fully understood. Its density must be quite low, for stars are visible through it. At least two comets

have grazed the sun, plowing through almost a million miles of the coronal material without being in the least retarded. It is not known whether the corona is being forced outward from the sun, or whether it is held in position by some other outside attracting force.

Of what is the sun composed? By spectroscopic analysis, the atmosphere of the sun is known to contain mostly hydrogen and helium. These two elements make up 99.9% of the volume of the sun's "air". The remaining elements or "imurities" are carbon, oxygen, nitrogen, neon, iron, silicon, magnesium, and calcium—elemtnts found in meteorites. (3) Most of them are in the ionized state, although a number of molecular compounds have been detected in the solar atmosphere. As for the main disk, determination of the composition of the interior is somewhat more difficult. It is known that hydrogen and helium also exist here in great quantities. Accurate knowledge of internal temperatures plays an important role in determining just how much of these two elements lie deep down in the hot globe.

So much for structure and composition. We will look at another amazing aspect of our bright neighbor, namely, its power. Just how vast is the strength of this body which bakes the planet Mercury, sears the surface of Venus, comfortably heats our earth, and is still strong enough to melt the iced polar caps of Mars? To get a beginning of an idea, let's consider a few interesting suppositions. James Sayre Pickering states that the energy output of the sun produced from a solar area the size of a pinhead would, at a distance of 5000 miles, be sufficient to blast the city of New York out of existence in an instant. Fourteen of the world's most powerful steam engines, operating at full capacity and each drawing a train of loaded cars a mile long require just about the same amount of energy that is emitted from a square yard of the sun's surface each second! This great amount of energy originates as radiation in the interior and works its way to the solar surface, changing to lower wave lengths along the way. Some waves of lengths injurious to human existence do reach the earth, but the amount is trifling after the rigorous screening afforded by 93,000,000 miles of space and our protective atmosphere. The visible band of light is short, and below it lie the infared and radio waves. Sensitive radio receiving devices have discovered that the sun actually hums. (The science of radio astronomy, still in its infancy stage has not only provided valuable data on the sun, but has also assisted in the mapping of the galactic empire and the garnering of information on a new concept—the supergalaxy. The Milky Way, peacetul to the eye, sets up quite a racket on radio telescopes.)

Now we shall consider the possible cources of the sun's power. How does the sun generate the power to supply the earth with a constant 1.94 calories per square centimeter per minute of terrestial soil? We marvel when we consider that this process has continued for millions of years, with no detectable change in this constant in all recorded history. Helmholz, the world's last true natural scientist, studied the problem of the source of the sun's radiation and proposed a theory of gravitational contraction, but not after first ruling out a few older ideas. He first questioned whether the heat could have been generated by a process of chemical combustion. His ecalculations quickly forced abandonment of this theory. If the sun were composed entirely of the finest grade of coal, the entire volume would have been consumed by combustion in less than 10,000 years. Helmholz then attacked a theory presented by Mayer in which the latter proposed that the heat was generated by a constant bombardment of meteoritic bodies onto the solar surface. If Mayer were right, thought Helmholz, would not the sun's mass have been greatly increased and would not the planets be subsequently drawn in closed to the sun with a corresponding increase in their orbital velocities? But the speeds of the planets around the sun is a long-standing constant. Mayer had to be wrong. Helmholz proposed that the sun was originally "spread out" in space and that by a continuous process of contraction and incomplete condensation heat was generated. Lord Kelvin and others supported this theory.

A solar flare in action. The hot gases may be the real cause of northern lights.

Einstein actually presented the most plausible explanation of the sun's source of energy when he made the connection between mass and energy. He reasoned that mass could be converted into energy and that the connection lay in the relationship, $E=MC^2$, where E is the energy, M the mass, and C the velocity of light. Prof. Hans A. Bethe of Cornell worked out a carbon cycle which today remains as a very effective explanation of this conversion in hot red stars. The cycle is actually the equivalent of the ancient alchemist's dream, the transmutation of elements. Bethe proposed that hydrogen is converted to helium resulting in an energy release, with a star's carbon acting as a catalyst which would be unaffected by the conversion and would renew itself to be used over and over again. It is estimated that 564,000,000 tons of solar hydrogen are converted to 560,000,000 tons of helium each second, the remaining 4,000,000 tons being radiated as energy. This radiation represents a loss of solar mass, but not a tragic one, because at this rate 0.1 per cent of the sun's mass will be diminished in 15 billion years! Were this energy not effectively filtered, the earth would be annihilated in a short time. As it is, we receive only a tiny fraction of this energy, in fact, only about 1 $2.2(10^9)th$ of it.

Another feature of the sun's power lies in its "hold" on the earth. Sir Isaac Newton stated in a theory that the gravitational attraction between two bodies is directly proportional to the product of their masses. Due to the large mass of the sun, its grip on us must be enormous. Actually, it is equivalent to the strength of a steel rod 3,000 miles in diameter, extending between the two bodies, and stretched to the breaking point.

Temperatures on the sun are fantastic. The calculation of interior temperatures is a point of great interest. The temperature at the solar surface can be easily calculated. Starting with this quantity, and knowing the mass of the sun, inner temperature can be determined. Each layer of the sun's mass must support the one above it. Pressures then, and temperatures, increase as one goes down deeper into the solar sphere. Using this method, the amazing estimated value for the central temperature has been found to be about 25,000,000 degrees Fahrenheit. Since heat "flows" only from hotter to cooler regions, the surface of the sun should be the coolest. The temperature of the photosphere has been calculated to be about 10,000 degrees Fahrenheit. But as was mentioned before, a mysterious situation arises. As we go on out still farther till we reach the corona, the temperature suddenly shoots up to 1,800,000° F—a fact which still faffles astronomers and seems to outrageously defy the second law of thermodynamics.

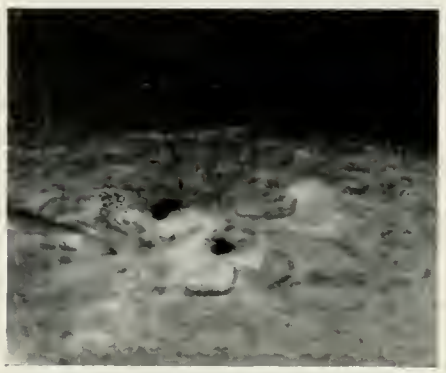
We are now ready to turn to some very interesting solar occurrences. Unlike our moon which is a lifeless hulk with no visible changes taking place on its surface, the sun is a storehouse of activity. We have already seen that the photosphere has a granular appearance which is constantly shifting and changing each minute. Then too, we have spoken of dark and bright clouds seen on the photosphere. Yet the most talked about of the solar cavortings are sunspots.

Sunspots appear as dark blotches against the bright face of the sun's disk. Closer examination reveals that a spot consists of a central dark region, or umbra, and a surrounding lighter shaded area called the penumbra. The spots are actually solar storms of fantastic proportions. (One spot observed in 1947 covered an area of five billion square miles.) They consist of a swirling vortex of gases which has originated in the interior and worked its way up to the photosphere. They appear darker than the surroundings because their gases are comparatively cooler than that of the neighboring regions. If isolated in space, one sunspot would appear as a tiny but brilliant speck of light. These solar "tornadoes" are probably nature's most effective refrigerators, for they reduce surface temperatures by more than 3000° F.

Sunspots are extremely peculiar individuals. Probably for reasons of their own, they choose to appear only around north and south (solar) latitude 30. They then make a pilgrimage about the solar disk, moving toward their equator in the process. Their journeys enable astronomers to determine the rotational period of the sun. (Here again was where another amazing discovery crept int. It was noted that the sun rotated faster at the equator than near the poles —a remarkable proof, indeed, that the sun is not a solid.) A German apothecary, Heinrich Schwabe (1789-1875), noted that the spots undergo a varying but consistent period of appearance. He found that on certain years a great number put in an appearance. With the passing of time, fewer and fewer were born until complete inactivity was reached. Then rebirth started anew and a maximum of activity was again reached. Schwabe timed the entire cycle and found it to be 11.3 years. The figure has undergone little revision and stands today as the symbol of Schwabe's persistence. The reasons for these periods are unknown.

Another unusual feature of our nomadic friends is the magnetic field associated with them. Spots appearing north of the solar equator and in the east were observed to be of opposite polarity with those to the west. South of the equator conditions are reversed. There appears to be some relationship between the direction of rotation of the swirling vortices and their polarity.

Prominences, or solar eruptions, are by far the most spectacular happenings on the sun. These flaming protuberances stretch out great distances from the chromosphere at irregular intervals. They generally reach heights as as 500,000 miles, and some travel at recorded speeds of 700,000 miles per hour. In one kind of prominence each successive velocity is a multiple of those preceding. These types are known as eruptive



A pair of sunspots, with their umbras showing, move across the face of the sun.

prominences, and they travel in straight lines from the photosphere. Another type is the active prominence, which moves in a curved path with much of the material returning to the sun.

Recent newspaper disclosures have put the sun in the headlines. A University of Oklahoma geography professor stirred dispute when he proposed that tides on the surface of the sun (caused by gravitational effects of planets may cause extreme weather conditions on earth. The geographer maintains that if sunspots come in cycles, so too, may there be regular tides which disturb the sun's surface and create cycles of weather on our planet. Many scientists refute the theory of long term weather cycles. Others assert that if tides do exist on the sun, they would be mere ripples, as the sun is so many times more massive than the planets which are providing the gravitational force of attraction. The "northern lights," or aurora borealis, has also been a subject handled recently by the dailies. These displays, according to the ancient belief, were reflections from the golden shields of the Valkyries, blond warrior maidens believed to escort the souls of dead heroes to Valhalla. But as we know today, they are shimmering particles lying 60 to 600 miles above the earth. It was observed that the auroral displays always appeared about twenty hours after the occurrence of solar flares. Because of the length of this time interval, the aurora could not be direct light from the sun, but some solar matter being ejected out toward the earth at the "slow" speed of a thousand miles per second. It was subsequently proved that the material was hydrogen atoms, and that these atoms have broken through the earth's magnetic "shield" and collided with nitrogen and oxygen atoms of our atmosphere. The energy of collision produces the light. But even as the newspapers will have us believe, there is a special reason for studying the aurora today. It has been found that they produce a serious disturbance of signals on radarscopes. An enemy plane could penetrate undetected deep into Canada from the Arctic during the confusion. To study the matter further, a thirty-nation group is preparing an auroral net for the 1957-58 sunspot maximum period. Present plans call for twenty-five Aerobee rockets with instruments to be sent up into the aurora borealis from Churchill, Canada, and eleven more from Alamogordo, New Mexico. Thirty-seven "rockoons" —rocket-carrying balloons—will also be released. Radio telescopes will be aimed through the aurora at distant stars in an effort to detect any radio waves which can penetrate this screen. Waves of this frequency could be utilized for arctic communication and other defense purposes.

And that is the story of the sun. It is not the complete story, however, for every day in many observatories throughout the world men are discovering many new and fascinating things about our bright neighbor. Typical of man's effort to know more about the sun is the McMath-ulbert Observatory of the University of Michigan. Here a group of towers house telescopes, solar spectographs, and other instruments with which motion pictures of solar features are made. Information gathered by these astronomical lookouts will provide valuable data that will make life more comfortable in the future. A solar battery has been developed already. In an effort to produce high temperatures so that metals for future aircraft may be tested, Convair has perfected a solar furnace which utilizes the sun's rays in producing amazingly high temperatures. The next step seems to be solar heating for homes. After that, who can tell? And the sun, unmindful of all this, continues to make its daily appearance in the sky—one blazing tribute to the men who study it and The Master Designer who placed it there. Perhaps the poet Blake was proposing a theory on the origin of the sun when he said,

" . . . *When the stars threw down their spears,*
And watered heaven with their tears
Did He smile His work to see?
Did He who made the Lamb make thee?"

Aluminum

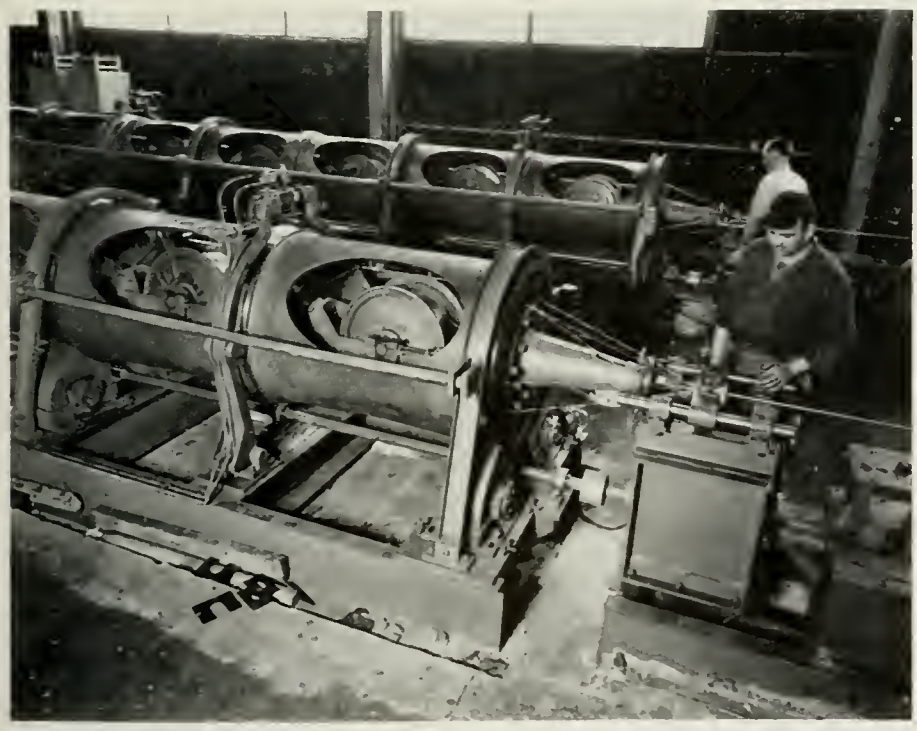
by Larry Kiefling, M. E. '56

One hundred years ago, aluminum was a precious metal worth $545 a pound. The most honored guests of Napoleon used forks and spoons of aluminum while lesser guests used gold service. Today aluminum ingot sells for 22 cents a pound and is finding more uses every day. The story of aluminum is a story of constant expansion and new products. Aluminum is now available from three independent, competitive sources, The Aluminum Company of America, Reynolds Metals Co., and Kaiser Aluminum Co., which produce about 50, 30, and 20 per cent of the U. S. supply respectively.

Aluminum sheet is available in various thicknesses. Sheets are hot rolled to a thickness of about $\frac{1}{8}$ inch and cold rolled when they are below $\frac{1}{8}$ inch. Annealing is used to relieve work-hardening of the metal. Rolled rods and various shaped bars are made in sizes down to about $\frac{3}{8}$ inch rod through a set of dies. Very fine wire may be drawn through holes in a diamond.

Channels, angles, I-beams and other structural shapes are formed on specially cut rolls which squeeze the hot metal into the desired shape. Odd shapes are formed by extrusion, the squeezing of hot (but solid) metal through a die. It is possible to make dies for almost any shape which may be desired.

Aluminum foil is a very thin sheet of metal. Foil can be rolled to only .00017 inches thick. A pound of this foil would make a sheet 5 feet wide and almost 100 feet long. Aluminum powwer can be made by several methods, depending on the intended uses of the powder. If the molten metal is sprayed into a stream of cold air which is moving rapidly upward, a powder composed of small spherical particles is formed. This atomized powder may be put into a ball mill if flat particles are wanted. Powder may also be made by putting pieces of foil into a special hammer mill. This powder is especially preferred for paint where the flat particles float to the surface and form an almost continuous layer.



These cable stranders wrap aluminum wires around the steel core wire. This cable is fifty per cent stronger and twenty per cent lighter than copper conductor of the same current carrying capacity. (Photos courtesy Reynolds Metals Co.)

Aluminum forgings are made by pressing or hammering the metal to the desired shape after it has been softened by heating. Cold forging can also be done by using enough force to work the metal. While pure aluminum does not make good castings, alloys can be readily cast. Sand castings are easily produced. Die casting is becoming increasingly popular due to the better surface finish, better tolerances, higher density, and cheaper production for a large number of parts.

Aluminum can be easily machined by most of the common metal working methods such as turning, milling, blanking, sawing, stamping, drilling, bending, and spinning. It can either be arc welded by the Heliarc method under an atmosphere of an inert gas such as argon or spot welded. It can be joined by all of the common metal joining methods.

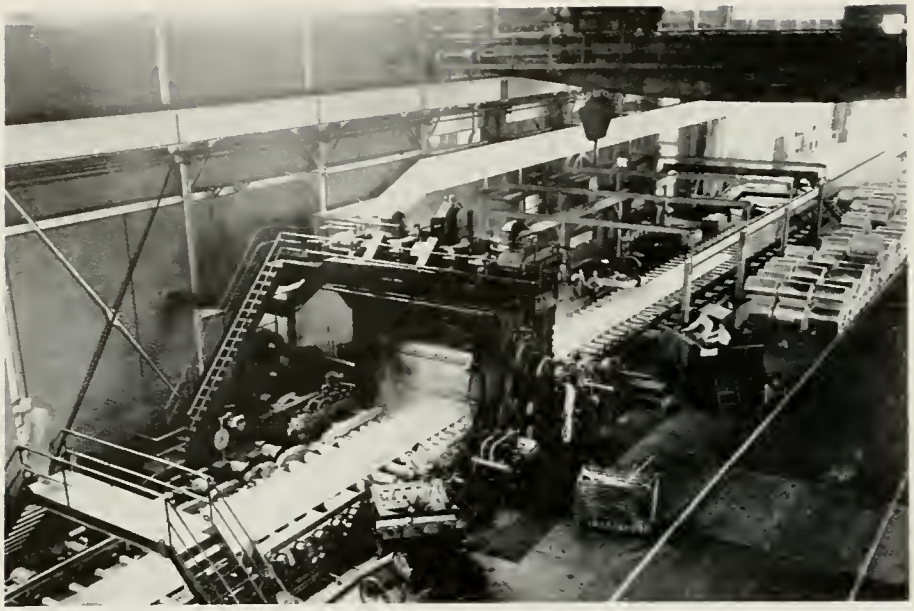
The metal that is called alumnium today is actually a family of aluminum alloys. Pure aluminum is relatively soft and weak. A tensile stress of 5000 psi will give the pure metal a permanent set. Small amounts of alloying metals can increase this strength about 14 times. These alloys have a strength comparable to that of some steels.

Uses of Aluminum in 1946 (per cent)

Building Products	18
Transportation	14
Cooking Utensils	11
Machinery	6
Household Appliances	6
Power Transmission	5

The diversified uses of aluminum are shown by the fact that only 60% of the total aluminum consumption is accounted for in the table. The rest of the metal is used in so many different and varied products that they cannot be listed in the table.

Aluminum is an ideal building material. Its bright, clean surface needs no paint and little maintenance. It is used for roofing, siding, windows, flashings, gutters, and downspouts. Entire skyscrapers are covered with panels of aluminum. Extruded shapes are used for window frames, railings, moldings, door sills, and copings. Heating and ventilating ducts and foil insulation also use large quantities of the metal. The low emisivity and high heat reflecting power of aluminum make it ideal for these



This four high reversing hot mill reduces the stock when rolling in either direction. Runout tables on each end may be up to 500 feet long.

around. The tub of one make of washing machine is an aluminum casting.

The electrical conductivity of aluminum is only 61% of that of copper on a cross section area basis, but is greater than copper on a weight basis. Aluminum Cable Steel Reinforced (ACSR) is now being widely used. It cuts line costs because it requires only about .7 as many poles as copper wire.

Many products either form too small a group to be listed in the table or have come into more widespread use since the table was made. Portable irrigation pipe made of aluminum is being more widely used. These pipes must be light and strong because they must be moved often. Aluminum foil is an ideal packaging material. Its use has been greatly expanded in recent years. It forms a metallic layer which is impervious to liquids and which can be shaper to surround the object which it protects. Labels and covers may be printed on foil to give an attractive ap-

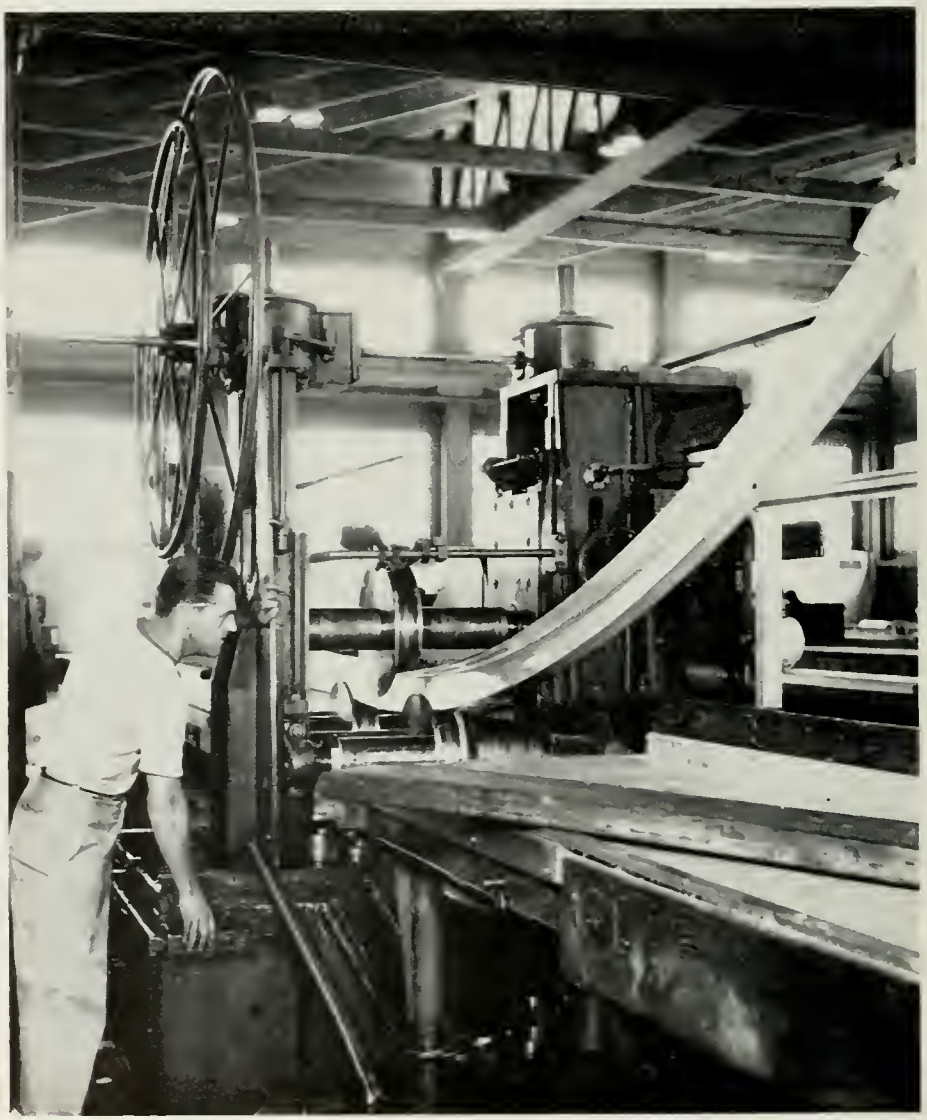
uses. Less heat is lost from aluminum ducts than from sheet steel ducts. Aluminum paint not only brightens up many surfaces but gives them the double protection of a layer of aluminum flakes and a coat of paint. Large numbers of aluminum grain bins have been erected in the past few years for the storage of surplus grain.

Aircraft designers were among the first to use aluminum extensively. The low ratio of weight to strength made it an ideal material for use in aircraft. Today's aircraft contain large amounts of aluminum alloys in both the surface and the structural members.

Railroads are using more aluminum in both their freight and passenger cars. The decrease in weight allows either a larger pay load or a reduced total weight which permits higher running speeds. Aluminum is being widely used for trailer bodies. Since the total weight of trucks is limited by state laws, a reduction in weight means an equal addition to the pay load. Aluminum is used for certain reciprocating parts such as pistons where each weight reduction helps to eliminate inertia forces and vibrations.

Aluminum is a popular material for cooking utensils. The tough, thin film of oxide always formed on the surface of aluminum is insoluble and impervious to food acids. Pots and pans need less scouring and cleaning. Quicker cooking is possible in aluminum ware. The lighter utensils are easier to handle.

Many household appliances have aluminum parts. Aluminum trays and shelves are used in refrigerators. Light weight is desired in appliances such as vacuum cleaners which must be moved



Bending an I-beam to form an arch for a self-supporting type building. The top roll can be moved up or down to control the amount of curvature.

pearance to a product.

Television is a good example of a new product which uses large quantities of aluminum. Light, strong, attractive antenna are made from the metal. So is the chassis and structure of many sets. Foil is used in making condensers for radio and television.

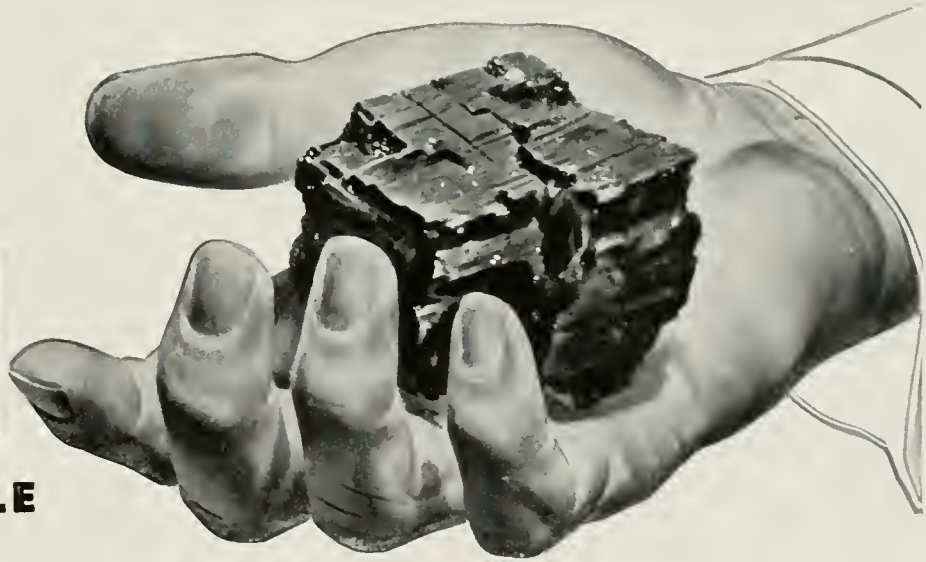
New developments such as color anodeized surfaces continually create new uses for aluminum. Innumerable small uses such as a part of a pencil, a new toy, a cigarette lighter, signs, license plates, motors, nails, furniture, tools, and beer barrels add up to use an enormous amount of the metal.

While aluminum has properties such as easy machinability, high ductility, good heat conduction, good electrical conduction, high heat and light reflection, no magnetism, high corrosion resistance ,good surface finish, and high flexibility which make it useful for certain applications, many of these properties also make aluminum unsuitable for other uses. The flexibiltiy of aluminum makes it a poor material where great stiffness is required. It cannot be used for springs where a high degree of elasticity is needed. It cannot be used where hardness is needed.

Alumnium parts for a well known coffee maker are being finished on an automatic polishing machine. The attractive natural finish helps to increase sales.

The price of aluminum compares favorably with the other non-ferrous metals, but it is still high when compared to iron and steel. Aluminum will never replace steel for many uses which require large amounts of a tough elastic metal unless the cost of aluminum is reduced and completely new alloys are discovered.

SO MUCH FROM SO LITTLE



You're looking at a kilowatt-hour* of electricity in its raw state—coal. This lump of coal weighs only 12 ounces. Not too long ago, the amount of coal required to produce a single kilowatt-hour of electricity was considerably larger and weighed 5 pounds. The difference between yesterday's 5 pounds and today's 12 ounces lies in improved steam technology, in better boilers—operating at higher pressures and temperatures—to make the steam that spins the turbines to make electric power.

Impressive as this progress appears, it represents only the current level of accomplishment in the quest for more and still more efficiency. Thanks to America's power engineers, continuing advances in the fields of metallurgy, combustion and design will make it possible to squeeze even more energy from a lump of coal.

*A kilowatt-hour will give you the power for, among other things, 10 solid hours of radio and recorded music, 14 hours of fan-cooling, better than 4½ hours of refrigeration operation.

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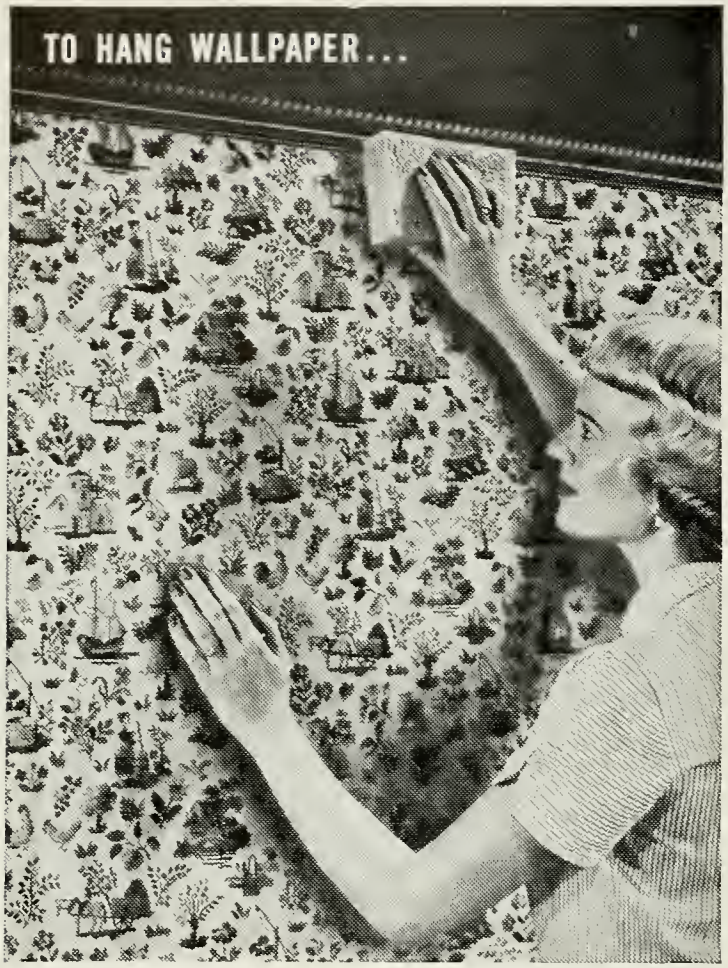

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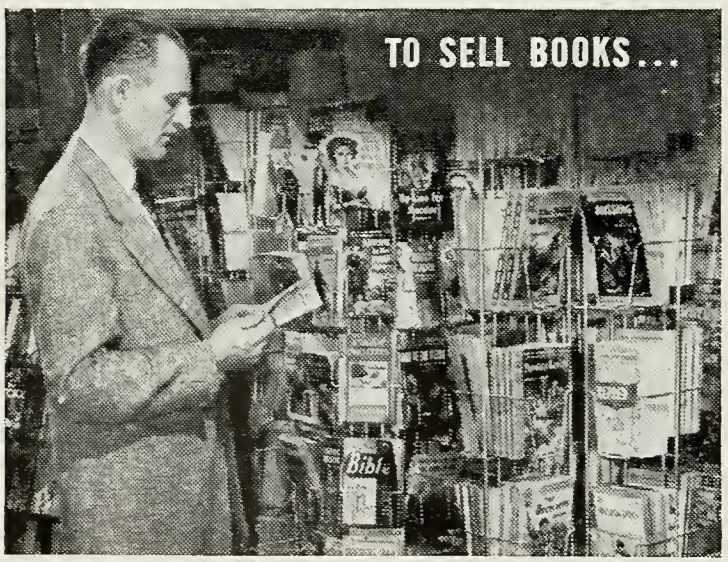

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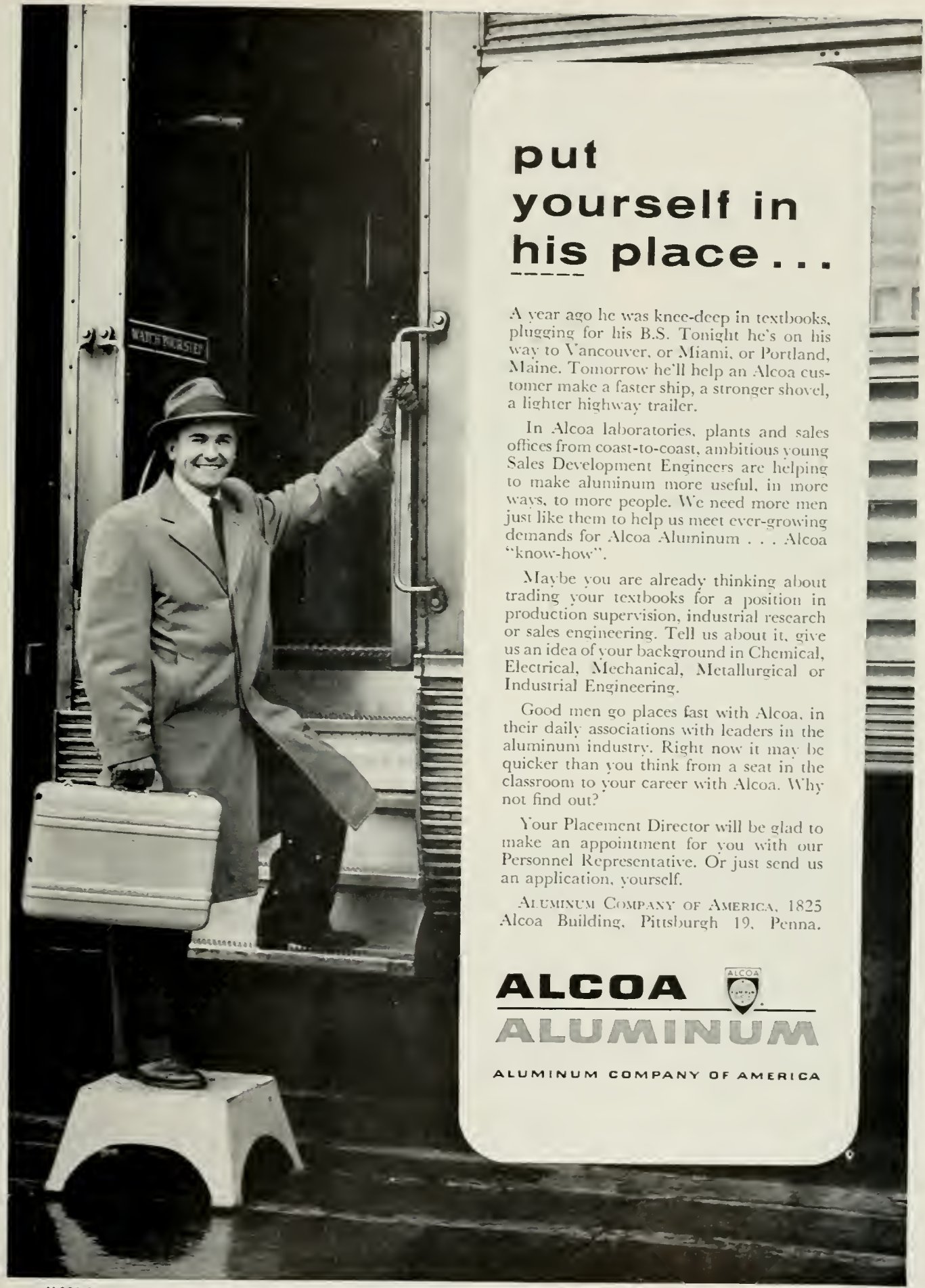

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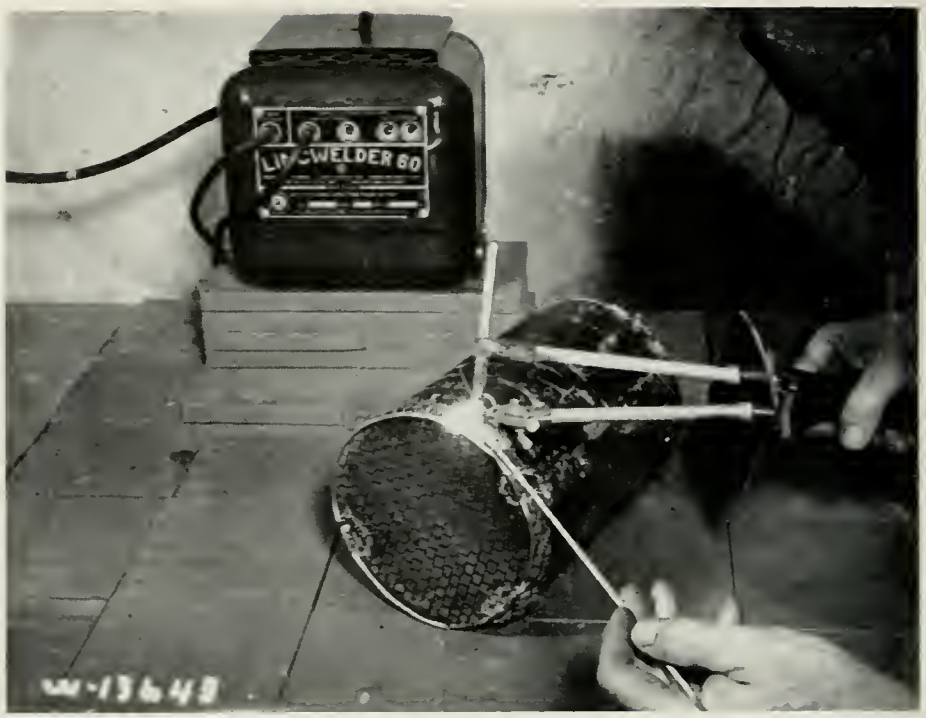
ARC Welding

by Don F. Kesler
E. E. '56



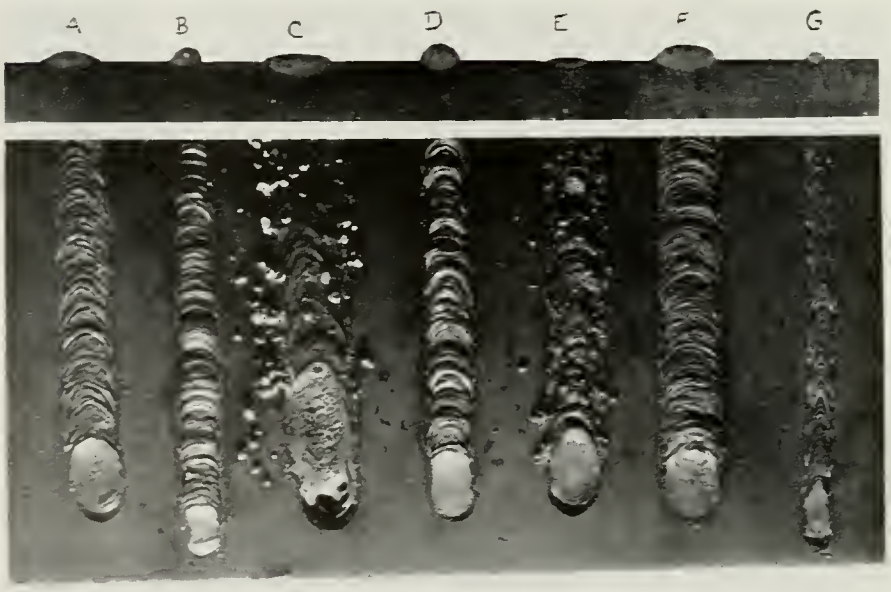
The carbon arc torch is one of the added attachments for the arc welder that can be used for heating or brazing. (Photos courtesy Lincoln Electric Co.)

Do you often wish you could weld? It doesn't take much welding to add up to a large bill. Think of the things you would build if you had a welder that you couldn't possibly do without one.

For a good dependable arc welder, you will have to pay from forty to sixty dollars for a sixty to eighty amp welder. Sixty amps will weld one-eighth inch iron in all shapes. This compares to seventy to a hundred dollars for the gas torches and regulators alone plus the cost of the gas and after thirty days, you would have to pay three cents a day per tank and demurrage costs. The oxygen and acetylene gas costs a total of about twelve dollars for two hundred and forty cubic foot tanks. Welding rods for the two types of welding are similar in cost.

An arc welder is an excellent tool for the amateur craftsman. It requires a modest amount of skill to operate and takes little time to learn. In two hours, you can weld things together. It takes eight to ten more hours of practice to make solid joints. After a month of welding a couple hours a day, you can weld with the skill of a commercial welder.

No one can tell you how to weld, but you can read how to *learn* to weld. First of all, you need an arc welder, several pounds of one-eighth or three-thirty-second inch welding rods, a welding helmet and a supply of one-eighth inch scrap iron. The importance of owning and *wearing* the helmet cannot be overemphasized. Many people have been blinded and lots of others temporarily blinded by welding or watching others weld without protective helmets with the proper dark glass. Caution, sun glasses are not sufficient protection. Be very careful not to let others watch while you are welding. The light given off by the arc is very bright and contains lost of infrared and ultraviolet light. Consequently it is advised that long sleeved shirts be worn while welding. A sunburn from an arc welder can be attained within twenty minutes and is very painful. A good book or pamphlet showing the differences between good and bad welds and what causes them is helpful in analyzing your welds. Study it and be able to recognize what you need to improve your welds.



The different mistakes and their couses: A. a good weld; B. too little current; C. too much current; D. too little voltage; E. too much voltage; F. moving too slow; G. moving too fast. D. and E. are not controllable in A. C. welders.

With the current set between sixty and eighty amps, the ground clamp attached to the iron and the shield in its proper position, start out by laying a bead. To strike the arc, hold the electrode with the holder at a seventy-five degree angle from the work and scratch the iron in a circular motion. Then raise it up about an eighth of an inch from the work. Since you failed to hold the arc, try it again. When you succeed you will notice the arc gets longer and goes out. This is because the metal melts off the tip of the electrode and deposits on the work, thus the distance from the tip of the rod to the work increases to the

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point where the arc goes out. To correct for this, keep moving the rod down at a rate that keeps the arc length constant.

When you finish the rod or the bead, knock the slag off with a hammar. Unless you had very good luck, the arc went out and you had several restarts. Run several more until you can go on a considerable distance without breaking the arc. Here you must analyze your welds. With the slag removed, compare your welds to those pictured. Correct one fault at a time until you consistently lay good beads.

Now you are prepared to join two pieces together. Take two pieces of eighth-inch iron and lay them down flat with their edges together. Connect the ground clamp to one of them. Lay a bead down the joint covering both sides. If you are average, you laid two beads—one on each piece with slag between them. Two mistakes—you didn't wait for the molten metal from both sides to flow together, then you went too fast. Watch the pool of metal, for just below the arc lies molten metal. The ring just beyond that is slag. When two pools are building up close to each other, they look like they are one to the untrained eye. However, if you look closely, there are two bright spots on each side with a ring between them. Just pour on the coal until they pop together. The new weld will follow the whole width as you move on to continue the weld.

When the work is cooling, you can see with the helmet removed two shades of red. The bright red is hot slag, while the reddish brown is cool metal or cool slag. When you see two dark spots with a bright one between, a slag hole is present. The hole full of slag cools slower than the thin layer of slag on the bead, thus a bright red spot can be seen. Knock off the slag and hold the arc on the spot until the two pools become one.

Sometimes it is necessary to join metal of two thicknesses by welding. The first question is how much current should I use? If you use the lower current, it won't penetrate the larger piece. Using the higher current will burn up the smaller piece of metal. The solution is to cut the current down a little from the larger current and point the tip to the heavier metal. Try to distribute the heat in the same way that the thicknesses are distributed. Experiment until you have a good weld.

A good weld depends upon penetration. The arc must melt some of the metal in the pieces to be joined and mix with it more metal from the rod to fill the gap and make one solid piece out of the two original pieces. Without this penetration the bead will project up high and will not stick. Watch the metal melt just in front of the pool under the arc. If it does not melt, you need more current and you may also be going too fast. Just keep practicing and soon you will become an expert.

There are many things a home craftsman can do with an arc welder. Power tool stands can be built by welding angle iron for the framework. Shop tables and benches can be built in the same way. Outdoor barbecue grille ironwork can be welded with an arc. The list could never reach the end because of the ever increasing uses for the arc welder.

An arc welder is just the same for the guy who wants to build a sports car or hot rod. The author did all the welding on his sports car with a small Lincoln arc welder. There are many places the arc is better than the torch. Some hard to get to places can be reached easier with an arc welder. The arc is a must if only a small area can be heated.

Welding rods are not just welding rods, for they are designed to do a certain job well. Some rods are for mild steel. Others are for high carbon steel, cast iron, or aluminum. Still others give some materials special properties. Plow shears are rebuilt with special rods that make them abrasive resistant. Another produces a hard tool like edge for resurfacing cutters. Both impact and wead resistance are combined in one to be used for earth moving blades. Machinability is a property of a special purpose arc welding rod.

Attachments broaden the uses of an arc welder tremendously. A carbon arc torch extends the uses to brazing, soldering and heating. Cutting can be done with only a copper covered carbon rod. A rectifier can be added for charging a car battery.

The arc welder is the ideal tool for the craftsman as well as the well equipper machine shop. A welder will pay for itself in a short time. An arc welder has a low initial cost as well as low operating costs and furthermore it is easy to learn to use.

A C-clamp is a common and useful tool that has been welded together from a horseshoe and a bolt.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, AND CIRCULATION REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233)

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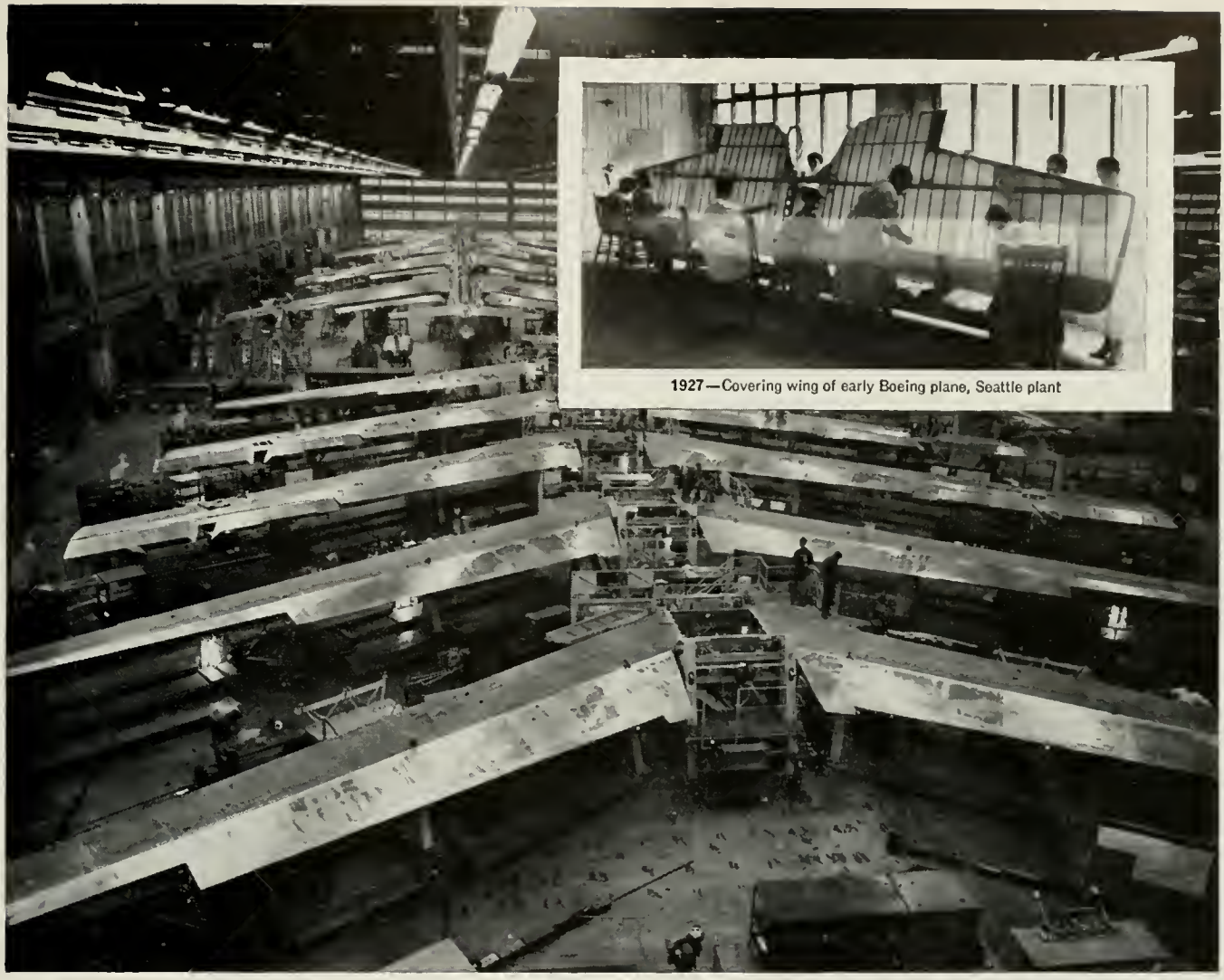
James E. Smith, Business Manager.

Sworn to and subscribed before me this 27th day of January, 1955.

(SEAL) Alice S. Hurt

(My commission expires July 24, 1955.)



1927—Covering wing of early Boeing plane, Seattle plant

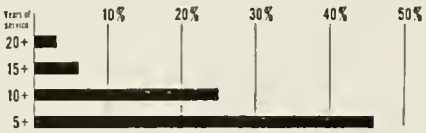
1955—B-47 Stratojet assembly, Boeing Wichita Division

Boeing offers engineers long-range careers

Throughout its 38-year history, Boeing has consistently pioneered advanced new types of military and commercial aircraft, and new methods of production. This history of leadership has meant continued growth for the company. It means continued opportunities for Boeing engineers to move ahead according to their ability in Research, Design and Production.

Today Boeing is producing the jet age's outstanding bombers, the B-52 and the B-47. Other Boeing projects that mean continued growth and stability include: America's first jet transport (the Boeing 707). Research in nuclear-powered and supersonic flight. And one of the nation's major guided missile programs. These and other new-horizon projects are expanding at such a rate that Boeing now employs more engineers than even at the peak of World War II.

The high inherent interest of these programs, together with the stimulation of expanding opportunities, add to the stability of careers at Boeing. One measure of stability is given in this chart.



It shows that 46% of Boeing engineers have been with the company for five or more years; 25% have been here 10 or more years, and 6% for 15 or more years. Another measure is the increasing proportion of engineers to total employees. Fifteen years ago the figure was one to 16. Today one out of each seven employees is an engineer.

Boeing promotes from within and holds regular merit reviews to assure individual recognition. Engineers are encouraged to take graduate studies while working and are reimbursed for all tuition expenses.

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Engineering Needs

by C. H. Shumaker

As the chief beneficiary of engineering training, American industry must assume a great share of responsibility for the solution of many problems now facing engineering schools. And, unless industry takes measures to eleminate inequities in compensation, the movement to organize engineers and engineering students into labor unions cannot be arrested.

These conclusions are reached in an article in the October issue of "Mechanical Engineering," official publication of The American Society of Mechanical Engineers.

The author, C. H. Shumaker, professor of management engineering at Southern Methodist University, cites the growth of technological knowledge in the past fifteen years as one such problem. The traditional four year curriculum, he states, is now inadequate for a comprehensive presentation of basic instruction to students.

Mr. Shumaker outlines steps now being taken in many schools to meet this problem. He points out, however, that none of these steps can be effective without the co-operation of industry. He lists two basic questions industry must keep in mind in expressing itself:

1. What type and how much training should the colleges provide in meeting industrial needs?

2. What effect will their recommendations have upon the cost of education, both to the student and to the college, and the ultimate effect upon the supply and quality of engineers?

Direct financial subsidization by industry of both engineering schools and employee engineers returning to school for advanced study is called for by Mr. Shumaker as a vital first step in the program.

The young engineer should also be encouraged by his employer to seek recognition through "licensing, membership in professional societies, and the attainment of official positions in such societies," according to the author. He states further that engineering faculties everywhere regard these activities as vital to the maintenance of professional standards.

"Unless industry fosters a desire on the part of younger engineers to avail themselves of these privileges," he continues, "there is little point in stressing them in college."

Compensation for engineers offers another field for reform according to Mr. Shumaker. Caught in the inflationary spiral in which the rising cost of living outdistances salary advances, engineers are a "so-called white collar class caught in a squeeze."

He also points out that the present practice of starting out graduating engineers at salaries above those paid to previously-hired engineers, in order to win them as employees, is further complicating the inequitable wage situation. Such discrimination, Mr. Shumaker states, encourages the present movement in both industry and in engineering schools to organize engineers for collective bargaining purposes.

Mr. Shumaker concludes his article by listing a ten-point program which, if adopted by industry, would aid colleges and universities in fulfilling their mission. The program calls for industry to:

1. Inform the colleges of changing needs requiring additional or improved engineering education.
2. Offer advice and counsel relative to the extent and type of engineering curricula best suited to industrial needs.
3. Give adequate recognition to the value of advanced degrees to those who acquire them before seeking employment.
4. Co-operate with engineering employees by making possible further education at least by giving them the time needed and preferably including financial assistance when required.
5. Give serious consideration to aiding recognized engineering colleges to meet rising costs, thereby insuring the company's own future.
6. Utilize engineering manpower to better advantage and recognize individual initiative and ability.
7. Eliminate discrimination and compensate engineers on the basis of their true worth.
8. Aid the maintenance of professional standards through a proper recognition of professional licensing and technical society activities.
9. Assist the colleges to combat the growing menace of unionization by furnishing concrete evidence that it is not necessary.
10. Stand ready at all times to offer the services of engineers and managers when they can be of assistance to the colleges.

Mr. Shumaker was recently nominated to serve as vice president in charge of ASME's Region VIII.

MORE STRENGTH FOR PAPER

A new impregnation method produces a paper which retains 90 per cent of its tensile strength after soaking in water. The impregnated paper also has more than ten times the abrasion resistance provided by ordinary impregnation techniques.

Soviet forces in Austria have added a new link to the chain of radar stations stretching from the Baltic to the Black Sea. Although most Soviet radar units in Austria are small and mobile, the latest bases in the Soviet zone are equipped with permanent radar installations.

BASEBALL IN THE AIR

The World Series was telecast live in Cuba through use of a DC-3. The plane, flying at 8,000 feet, picked up the signal from Miami and relayed it via microwave to the Cuban national network.

RADIOACTIVE COWS

A number of questions concerning milk are being investigated at Oak Ridge, Tenn., through research with radioactive tracers. Studies are aimed at reasons for the amount of calcium in milk (as compared to that in blood), how the cow's mammary gland can use blood constituents in synthesis of new substances common to milk but not found in blood; and what regulates the process whereby the cow uses minerals from her own skeleton when demands are in excess of the amount furnished by her diet.

FOR FISHERMEN ONLY

The Soviet Fishing Authority has placed a substantial radio order with a British firm for transmitters, all-wave receivers, combined medium and short-wave direction finders and associated units. The units will be used on 20 deep-sea fishing vessels, now under construction in Russia.

CURB ON CHEWING

Pills now can be made with an outer coating so hard that they can't be chewed. The coating, recently invented by a pharmaceutical firm, is intended to protect the mouth from discoloring dyes used for diagnosis and from unpleasant-tasting medicines.

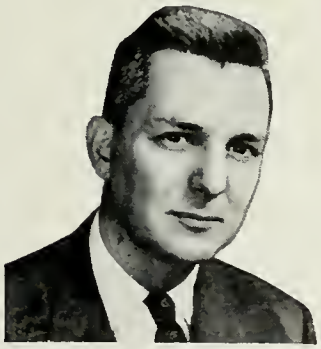
AUTOS FOR SPAIN

A Spanish automobile firm, Sociedad Espanola de Automoviles de Turismo, plans to produce 10,000 cars a year "within a very short time." Ultimately, when the market can absorb them, the firm plans to produce 200,000 cars annually.

"Dress" Pruett wants to know:

What type of training program does Du Pont have?

DRESSLAR M. PRUETT expects to receive his B.S. in Industrial Engineering this summer from Oklahoma Agricultural and Mechanical College at Stillwater, Okla. He is president of the local student branch of A.I.I.E. Naturally, he is interested in selecting the best job opportunity for a successful career based on his technical training.



DONALD C. MILLER received his B.S. in Chemical Engineering from Ohio State University in June 1937. During the following month he started work with the Organic Chemicals Department of Du Pont at Deepwater Point, N. J. Since then he has received and given many kinds of technical training. Today Don Miller is a general superintendent at Du Pont's Chambers Works—well qualified to answer questions about training programs for college men.

Don Miller answers:

Training has many facets in a big firm like Du Pont, Dress, and a great deal of thought has been given to make it truly effective. We look upon training as a very important factor in a man's career. We think that the best way to train a college graduate is to give him a maximum of on-the-job responsibility in a minimum length of time. That's the general guiding policy at Du Pont, Dress.

Of course, each department varies this general policy to suit its special needs. A new man being trained for production supervision may first spend a year or so in laboratory or plant development work. Or he may spend his training period as a plant operator. Thus a man obtains firsthand knowledge of his process, and establishes a bond of mutual respect with the men he'll be working with on his first major assignment.

A young man interested in sales is often first assigned to a plant or laboratory dealing with the products he will later sell; or he may join a group of trainees to learn selling techniques right from the start.

An engineer, chemist, or other technical graduate is usually chosen for a specific job within his major field of study. Such a man brings specialized knowledge and skill to his job, and he is encouraged to put them to use promptly. But at Du Pont his experiences on the job are supplemented with lectures, conferences and discussion groups. In a very real sense, new technical employees continue training in their specialties after joining the Company.

To sum it all up, Dress, Du Pont's training program is individualized to provide a new man with specific opportunities to learn from contacts with more experienced men. The *prime objective* of Du Pont training is always kept clearly in mind—to develop men for future advancement and effectiveness in the organization.

NOW AVAILABLE for student ASME chapters and other college groups, a 16-mm. sound-color movie—"Mechanical Engineering at Du Pont." For further information write to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Bldg., Wilmington 98, Delaware.

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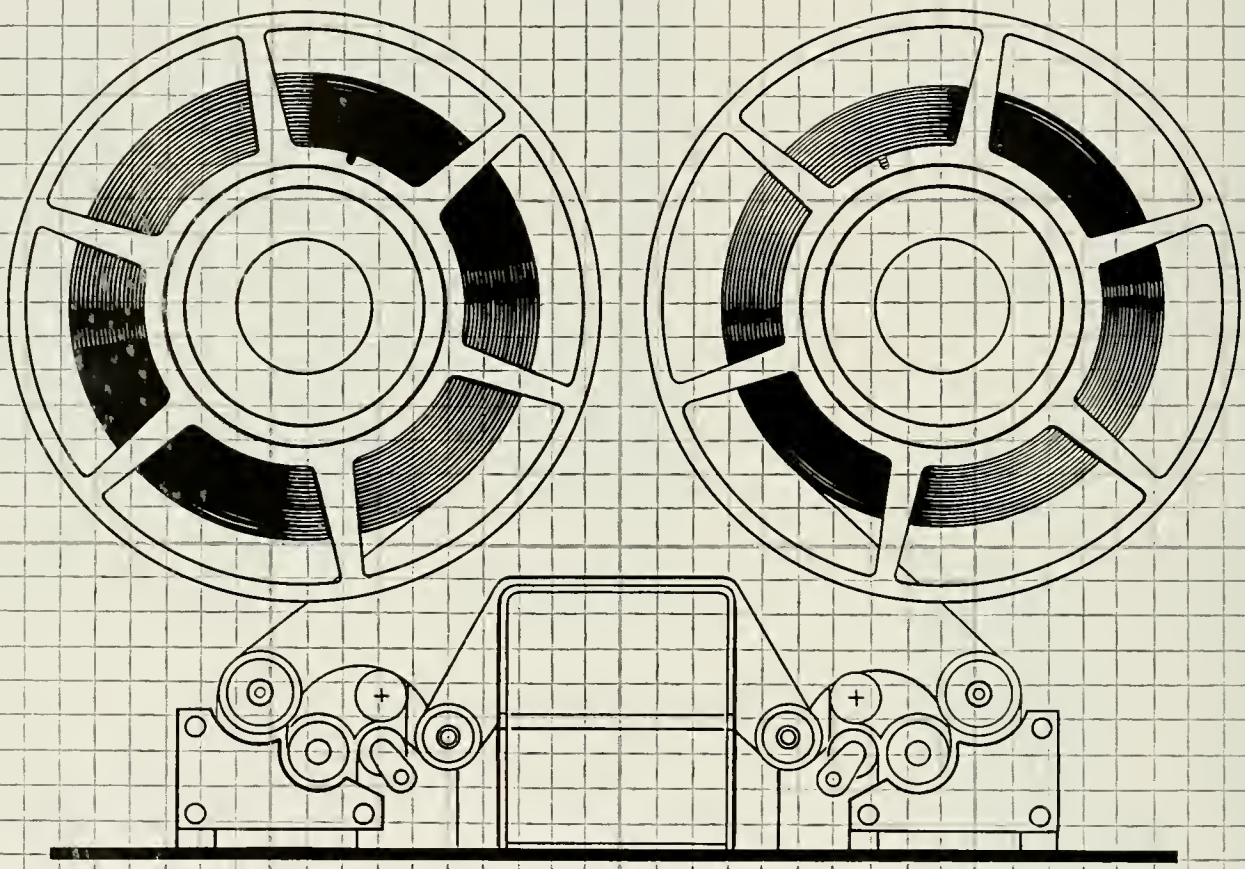

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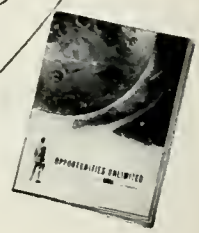

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Synthetic Gems

by Jack Kerr, Cer. E. '56

Of the myriad precious and semi-precious stones present in nature, only a few can be duplicated synthetically. Luckily, the few that can be produced synthetically are the ones most important commercially; with the exception of diamonds. These fall basically into two groups. One group is composed of aluminum oxide and modifications of this compound. This basic substance is called corundum or spinel, according to composition. The second basic group uses rutile as a base.

In the corundum group there are such synthetic stones as ruby, sapphire, zircon, garnet, topaz, amethyst, aquamarine, and alexandrite. In the spinel compound such synthetic stones as emerald and the emerald variety of beryl can be produced. In the individual groups the various stones are produced by adding tiny amounts of metal oxides to add the correct color.

The commercial method of producing corundum is the same as the one developed in the laboratory of Verneuil, a French chemist of the early nineteen hundreds. The boule, as the formation of the substance is called, is formed on a slowly revolving ceramic rod by dropping aluminum oxide (Al_2O_3) through an oxy-hydrogen flame. The alumina is melted before it hits the rod and there it slowly cools and solidifies into an elongated ellipse. This cooled mass has assumed the crystalline structure of the various gems contained in this group. This boule may weigh hundreds of carats.

The synthetic stone titania is a true synthetic gem in that there is no stone like it found in nature. It is called a night stone because of the fact it sparkles brighter under electric light than in daylight. It has the play of colors equal to opal and the brilliancy of a diamond. The reason for its brilliancy and colors being that it has a small crystalline structure and refracts light much better than other stones. These stones were developed as a result of research in the field of paint pigments. The basic element for the titania gem is a substance called rutile. It is made up of titanium oxide. The boule is formed by the same process as corundum but in a more intense flame. In paint pigments the rutile is ground up into a very fine powder and added to give brightness to the paint. It was the experimentation with crystals of rutile that led to the discovery of titania gems. The gems can be made in colors ranging from yellow to deep blue and their beauty rivals that of natural stones.

There are several methods of detecting synthetic emeralds but no one method alone is positive. Most natural stones have three phase inclusions and synthetic stones never do. A three phase inclusion is one in which there are all three states of matter, liquid, gas, and solid, combined in the same inclusion. Another method to detect a synthetic emerald is to put the stone in question under strong ultra violet radiation. The synthetic stone fluoresces strongly while the natural stone does not.

Natural emeralds from different parts of the world have different shaped inclusions. The emeralds from Russia have diamond shaped inclusions while those from Colombia have square crystal inclusions.

The chemical composition of synthetic sapphire is the same as that of corundum. It is merely aluminum oxide with a tiny amount of magnetic iron oxide or titanic oxide or chromium to give it the desired color. In making the star sapphire synthetically there is some trouble encountered. The star shape in a sapphire is caused by the reflection of light from elongated bubbles of air in the stone. These bubbles, or inclusions, are in the form of a six pointed star and it shows brilliantly in the jewel. There is a known process for the manufacture of the star sapphire but the makers have kept it a closely guarded secret. These synthetic star sapphires can be produced in red, blue, violet, soft grey, and pink.

The detection of the synthetic stone is relatively simple and generally a surefire one. Natural sapphire will sink in a dilute solution of methylene iodide (CH_2I_2) but the synthetic ones will float. There are several other tests which are not as sure but are very effective when used together. In synthetic sapphire the inclusions are usually perfectly round while in natural sapphire the inclusions are irregular or resemble the shape of the crystal. If included particles are to be seen, they are arranged in curves in synthetic and are irregularly distributed in natural sapphire.

In natural sapphire the striae are straight while in synthetic the striae, or lines of stress, are curved. The coloration in synthetic sapphire is often wrong in that it appears glassy and too evenly distributed. In natural sapphire the color is often not uniform and when it occurs in bands, the bands are either parallel or irregular. There are also tests using specific gravity and index of refraction but most synthetic stones are so close to natural ones in these two respects that the tests are often not valid.

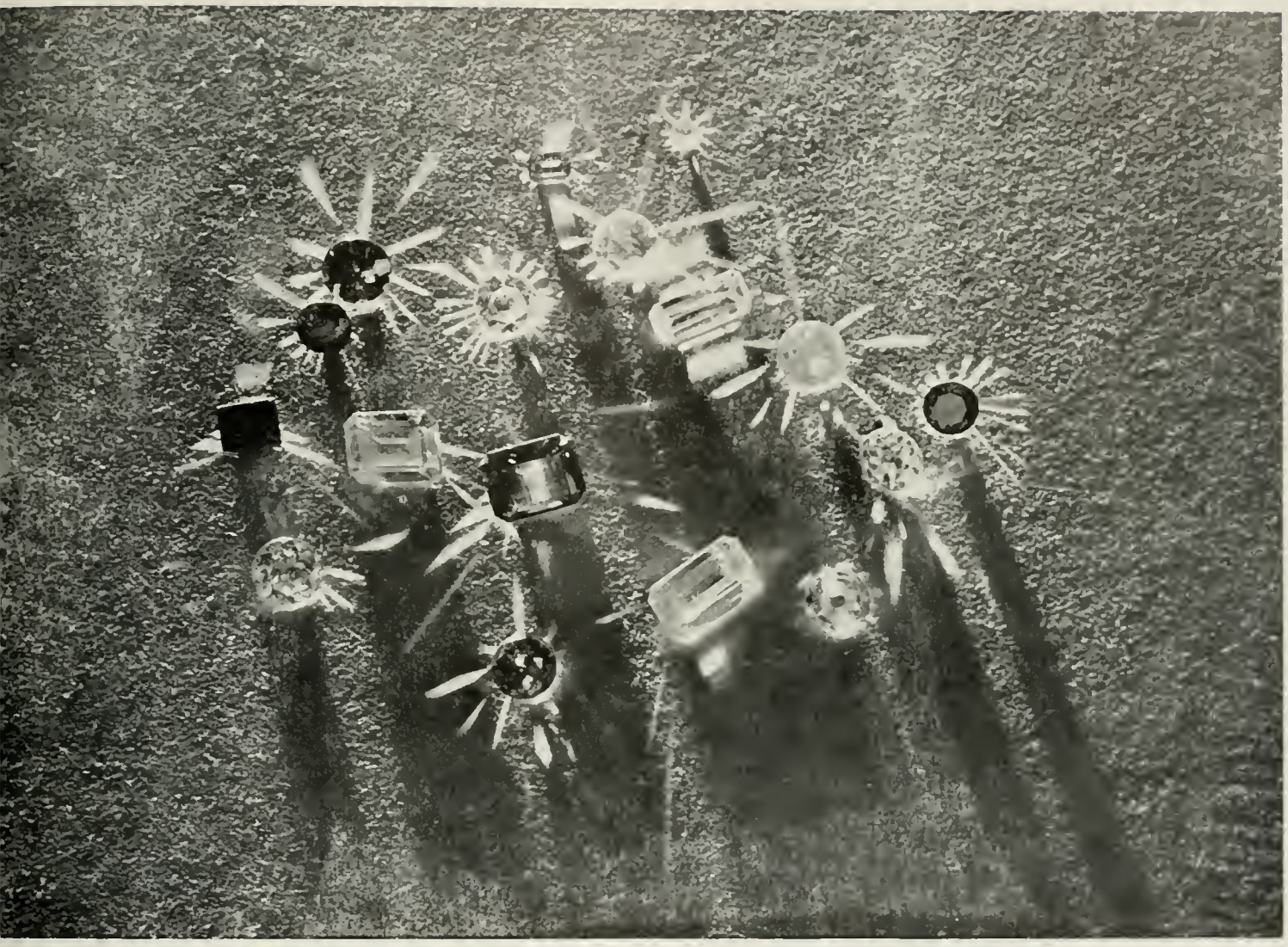
In the synthesis of rubies the basic material is corundum, the same as synthetic sapphire. The coloring agent used is bichromate of potash.

The methods of detecting the synthetic ruby are similar, with the exception of the flotation in dilute methylene iodide, as those used for the detection of synthetic sapphire.

The diamond has been produced in the laboratory of a French chemist named Moisson. His process is a very unsatisfactory one in that it doesn't always produce the synthetic stone and when it does, there are only a few very small stones produced. Moissons' process is to mix iron and carbon and heat the mass to fusion in an electric furnace. It is kept in a 4000°C. temperature for a short time and then plunged into cold water. The iron on the outside forms a crust and the rapidly expanding interior is confined. This creates enormous pressure and some of the carbon is crystallized into diamond.

As one can see, this is not a commercial method for producing diamonds synthetically and is a very haphazard method at best. It is the only way to produce diamonds at all.

There are several general methods of detecting synthetic gem stones. Certain tests that are good in some cases are worthless in others, however. The test for specific gravity in all stones manufactured from corundum is of no value because stones in this class are within .003 of the specific gravity of natural stones. The refractive indices of these same stones are the same in both natural and synthetic. There are, however, certain things that are indicative of synthetic gems. Synthetic corundum has circular inclusions that are usually symmetrical while natural corundum has angular inclusions. These inclusions in natural corundum may assume needle-like shapes and if they do, they make an



These synthetic gems if mounted in rings would cost only one-twentieth the amount of real stones. (Photo courtesy Science Service)

angle of sixty degrees with each other in sets of three parallel lines. Synthetic corundum also may have small crystals of zircon as inclusions in it. These can be detected by strong magnification or refractive index. The striae, or growth lines, of the natural stone are always parallel or irregular while those of the synthetic stone are always curved. These growth lines are visible when the stone is viewed perpendicular to the long axis of the boule.

The purpose for the manufacture of synthetic gems is not to provide cheap gems for jewelry. The widest market for gems, both synthetic and natural, is the commercial market. Here the gems are used as bearings in watches, gauges, meters, and other places where friction is present and must be cut down. The gem's suitability for this role is the fact it is very hard. Most of the gems mentioned in this paper are harder than metal and herein lies their value.

In the modern small airplane there are over a hundred jewels in the instrument panel. Wristwatches are advertised as having so many jewels in the movement. Generally, the more jewels, the better the wristwatch.

Switching to a different use, diamond impregnated copper saws are used to cut extremely hard substances such as granite. These saws utilize the fact that diamond is very hard and the friction of the saw wears through the rock before it wears through the saw. In the same line, diamond dust or finely powdered diamond is used as a polishing agent.

The one way most people see gems is as jewelry. There are a variety of ways gems are used in jewelry, some of which are as rings, broaches, ear rings, pendants, lockets, tie clasps, and many others. Synthetic gems fit right in this picture because of their similar physical and chemical characteristics and also because of their much lower price. To the ordinary person there is no visible difference between a natural stone and a synthetic stone and since the price is much lower, they buy the synthetic stone. The manufacturers guard very carefully against flooding the market with synthetic stones and thus bringing the price down.

The synthetic gem is one of the most important synthesized materials in production today. It is also one of the least publicized and most unknown article on production. For the most part, the processes are closely guarded secrets and most people never know how much of the jewelry and precision machine bearings are made of synthetic gems. Their discovery has helped make America less dependent on foreign sources of the natural gems.

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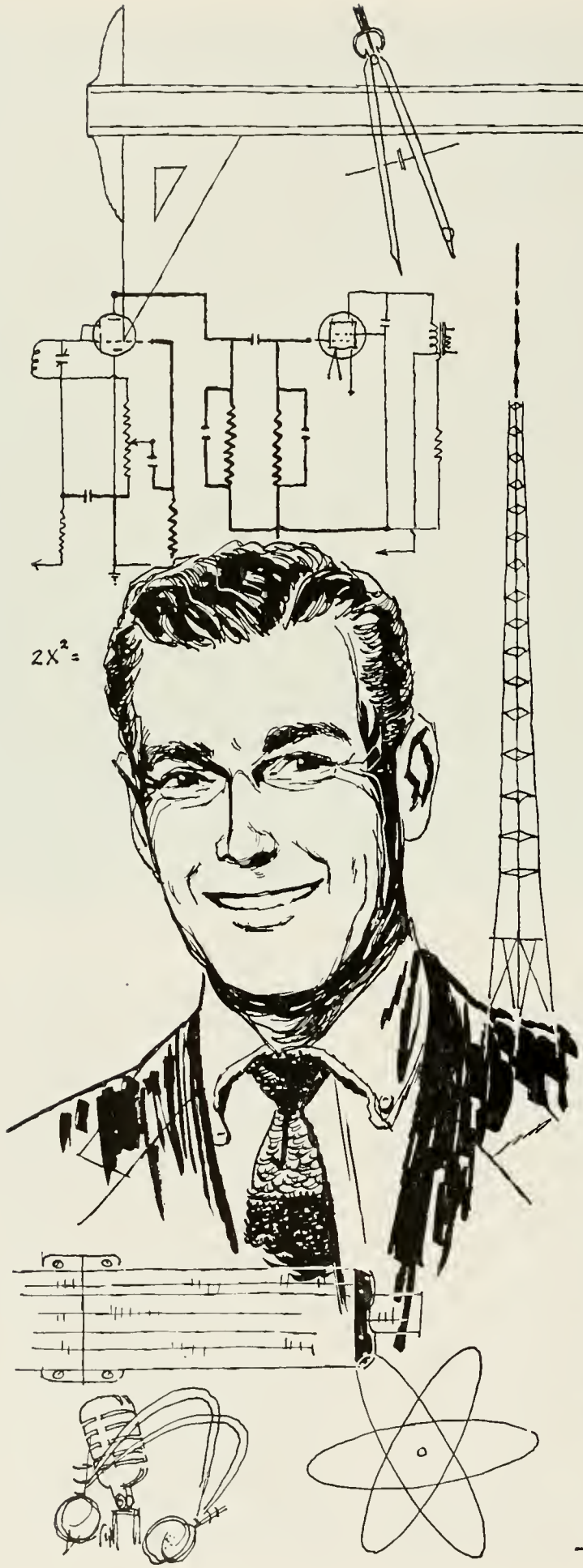

To the graduating engineer who wants his first job to be the right one

The temptation is great to take the first job that comes along. Especially when the salary looks so big after scrimping to make ends meet through 4 or more years of college. But, it's a mistake not to weigh that "first job" decision carefully. Because, like in most everything else, getting the right start is mighty important.

We believe you will do well to consider taking your first job with Collins Radio Company, and we'll tell you why. First of all, Collins is a large company that is continuing to grow and expand rapidly. *Because* it is a big company, and one of the leaders in the field of electronics, with research and manufacturing plants in Cedar Rapids, Iowa, Dallas, Texas, and Burbank, California, present opportunities are great. And, because Collins is a company that is expanding rapidly, future opportunities are unlimited.

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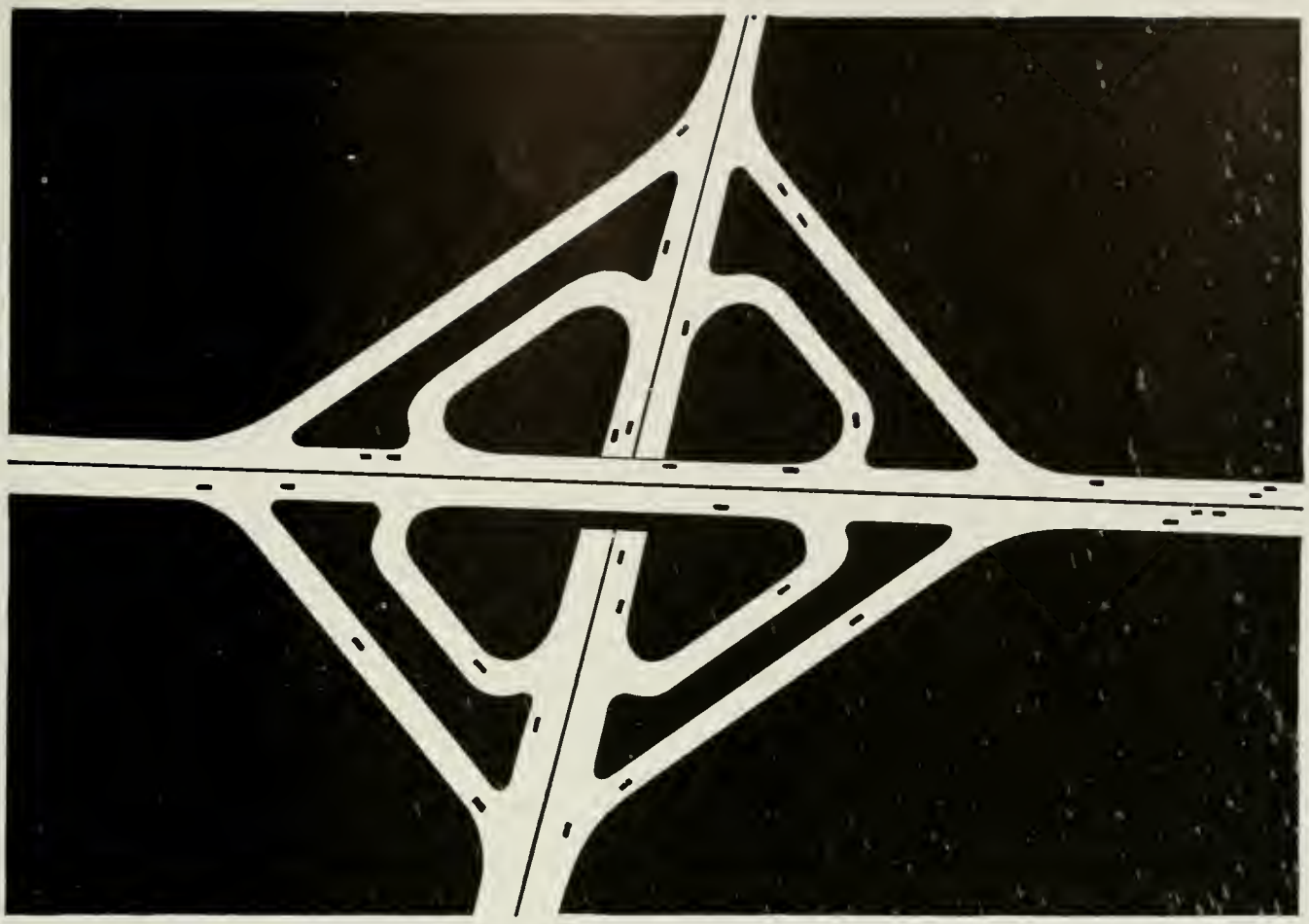

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HEADQUARTERS FOR TECHNICAL AND BUSINESS INFORMATION

Preparation of Rubber Insulation and Jacket Compounds

MATERIALS AND THEIR PREPARATION. The materials used in the preparation of rubber insulation and jacket compounds may consist of natural or synthetic rubber along with mineral rubber and reclaimed rubber and the necessary compounding ingredients consisting of anti-oxidants, fillers, pigments, plasticizers and vulcanizing agents. The rubber or rubber-like materials are given a preliminary mastication or break-down on rubber mills or internal mixers to facilitate subsequent compounding operations. They are stored in a suitable form until required for compounding.

The required compounding ingredients, except the vulcanizing agents, used in insulating compounds, are carefully weighed into a suitable container. The plasticized rubber or rubber-like materials are weighed last. The vulcanizing agents are weighed in a separate container.

COMPOUND MIXING. Rubber insulation and jacket compounds may be mixed on rubber mills or in internal mixers.

The rubber mill consists of two driven rolls about 28 inches in diameter and from 60 to 84 inches in length. The axes of the rolls are held in a single horizontal plane by the mill frame above a suitable pan. Adjustments are provided to control the spacing between the rolls. Each roll is equipped—for water circulation—for cooling. The rolls rotate in opposite directions in such a manner that the surfaces approach each other at the top. The surface speed of the back roll is about 1.2 times that of the front roll. This difference in surface speed assists greatly in break-down of the rubber and incorporation of the compounding materials.

The rubber-like materials, and mineral rubber, when used, are placed between the rolls first and masticated until so plasticized that they form a continuous sheet on the front roll. The solid ingredients, except the vulcanizing agents for insulating compounds, are then placed on the mill and incorporated in the rubbers. Any solids which drop between the rolls are retained in the mill pan and then returned to the mill.

After the solid materials have been incorporated, the batch is thoroughly blended by cutting the rubber sheet about half way

across the roll from alternate ends and folding it back over the uncut portion. This blending may require about fifteen minutes and the entire mixing cycle approximately a half hour. After blending, the compound is removed from the mill in rolls suitable for feeding to the strainer.

The internal mixing unit consists of a mixer located above a rubber mill. The mixer consists of essentially two rotors with spiraled blades rotating in opposite directions at different speeds in a closed chamber. The direction of the spiral of the blades changes at the middle of the rolls. An air-controlled ram forces the materials into the mixing chamber. The mixed batch is discharged from the bottom through a hydraulically operated gate.

The effectiveness of the internal mixer as compared with the mill for breaking down and compounding rubber is evident from a consideration of its method of operation. In addition to the difference in the rate of rotation of the rotors, the interrupted spiral of the blades produces a continuous and uniform movement of the compound

Compound mixing

from the middle to the ends of the rotors. The walls of the chamber are stationary and hence the difference in rate of movement of material adjacent to the rotors and the walls is great. These conditions insure that every part of the batch being mixed will come in contact with every other part in a relatively short time. Mixing requires about fifteen minutes. After mixing, the compound is discharged to the mill below from which it is removed in a form suitable for feeding to the strainer.

STRAINING. The strainer consists essentially of a mechanically driven screw located in a cylindrical cast iron housing. The housing is provided with an opening for feeding the screw and supports the head of the strainer. The head at the outlet end of the screw provides a suitable support for a thirty-six mesh screen through which the rubber insulating compounds are forced by the screw. The strainer operates on the same general principle as the ordinary household food chopper.

The mixed compound is fed into the strainer and forced through the screen. Large particles of foreign or undispersed materials are retained on the screen. The strained rubber compound is returned to a mixing mill or internal mixer where the vulcanizing agents are added. The complete insulating compound is then removed from the mill in sheets for immediate application to wire or for storage.

Jacket compounds are prepared in the same general way as insulating compounds except that the vulcanizing agents are incorporated along with the other solid fillers in mill mixing or on the sheeting mill of the internal mixing unit. Jacket compounds are not strained.

LATEX COMPOUNDING. Compounding rubber in the form of latex involves the handling of rubber in the form of a liquid and, therefore, requires lighter and less costly equipment than that just described for the compounding of plastic rubber. In addition to the actual preparation of the compound, it involves, for latex insulation, the purification of the rubber in latex form.

Latex rubber is purified by diluting a known quantity of latex to approximately 33 per cent solids and heating to a temperature of 150°F. in a steel tank provided with a stirrer. The required amount of creaming agent, dissolved in water, is then added and the mixture stirred. The stirring is discontinued and the warm latex allowed to stand for about 48 hours. The rubber, being lighter than water, rises to the top in much the same way that cream separates from milk. The bottom layer, the serum containing the major portion of the impurities, is discarded leaving the purified rubber in the form of a cream in the tank. This process is repeated until rubber of the desired purity is obtained.

For use in latex compounds, ordinary rubber compounding ingredients are ground more finely, thoroughly protected, and wet with water. This is accomplished in a ball mill. A ball mill consists of a porcelain lined steel drum, provided with a suitable opening and supported with its axis horizontal in such a manner that it can be rotated. The cylinder is about half-filled with flint pebbles.

Definite amounts of the various compounding ingredients, together with the required amounts of protective agents and water, are then placed in the ball mill and suitably ground. Sulfur, being the most difficult material to grind, wet and protect, is milled for about three weeks. All the other ingredients require about one week.

The required amounts of these properly protected and wet ingredients are then carefully weighed and added, along with the stabilizers and water, to a known amount of purified rubber, in the form of latex. The mixture is stirred for about two hours to insure thorough mixing. It is then transferred through a 100 mesh strainer to a storage tank until applied to wire.

Latex compounding

R U B B E R C O M P A N Y.
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Der Delta

by Robert Shanahan, Aero E. '56

During World War II it became increasingly evident to men of the Aeronautical Sciences that with their tremendous increase in knowledge of aeronautics there remained but few obstacles to deter them from reaching their long dreamed of goal, the airmen's four minute mile, the breaking of the sound barrier, the achievement of Mach 1 plus.

The German aircraft industries, the industries that produced the world's first flyable rocket plane, the Messerschmitt ME 163, and the world's first rocket propelled pilotless aircraft, the FZG 76 (V2) flying bomb, were again striving hard to scoop the world. This time they were working on prototypes of aircraft to operate in the range of Mach 1.

One of these prototypes was the modern proposal of a delta-wing planform. It was originated by the German scientist Dr. Alexander Lippisch. He was long associated with Deutches Forshungsanstitut fur Segelflug in the development of tailless gliders during the period of the honored armistice with Germany which forbid powered aircraft.

During World War II he was associated with Professor William Messerschmitt in the development of the aforementioned ME 163 Schwalbe. This Schwalbe featured sharply swept back wings, something radical at that time. Shortly after completing consulting work on this project he was appointed president of Luftfahrtforshung Wren, an aeronautical research laboratory near Vienna. It was at this lab that he developed his ideas concerning supersonic aircraft design.

His studies on supersonic airframes came about due to his interest in the Lorin propulsive duct or the ramjet engine. When his investigation of the propulsive duct had passed the wind-tunnel and flying model stage, Dr. Lippisch began design of a supersonic airframe to further test his power plant.

This airframe project of Dr. Lippisch's was designated the L 13 a. It had a delta wing planform and the wings were swept back at an angle of sixty degrees. (The sweepback of sixty degrees is the true delta wing aircraft, the name being taken from the Greek letter "delta" whose symbol is an equilateral triangle.)

Dr. Lippisch's ramjet engine was built integrally with the center section of the wing.

The L13a was to weigh 5,060 pounds and its speed was estimated at 1,020 miles per hour. Dr. Lippisch had incorporated several interesting features into his design. They included an elliptical airfoil section which he predicted would minimize transonic stability problems, a gap of about three per cent chord, between wing trailing edge and control surfaces to permit large control surface movement to minimize the danger of reversal due to the formation of shock waves on the leading edge. He also planned to have cooling air ducts between the center section and the outer wing panels to isolate the heat of the engine.

A model of the L13a was tested in the Gottingen highspeed wind tunnel up to Mach 2.6. These tests showed the design to have marginal stability at high speed and wholly insufficient stability at low speeds.

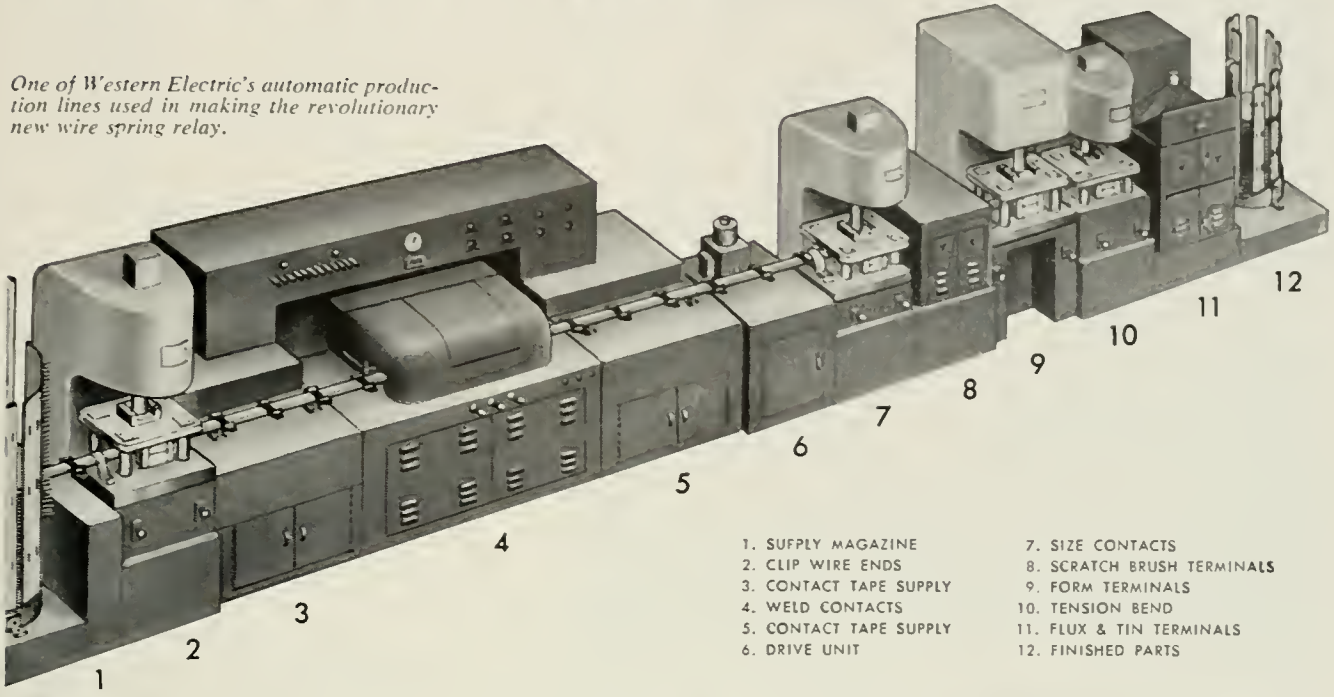
For stability investigation purposes a glider version of the L13a was built by the Flugtechnische Fachgruppe Darmstadt. The glider was made of wood and plastic and carried a pilot in the center

The XF-92A is an interesting experiment in delta wing aircraft.

AUTOMATION at work

How a revolutionary new design was translated into a production reality

One of Western Electric's automatic production lines used in making the revolutionary new wire spring relay.



1. SUPPLY MAGAZINE
2. CLIP WIRE ENDS
3. CONTACT TAPE SUPPLY
4. WELD CONTACTS
5. CONTACT TAPE SUPPLY
6. DRIVE UNIT
7. SIZE CONTACTS
8. SCRATCH BRUSH TERMINALS
9. FORM TERMINALS
10. TENSION BEND
11. FLUX & TIN TERMINALS
12. FINISHED PARTS

So great was the departure in design of the new Bell System wire spring relay as compared with conventional relays that it posed a major undertaking for development engineers at Western Electric, the manufacturing and supply unit of the Bell System. Indeed, it was an undertaking that called for new machines and new methods because none was available to do the job.

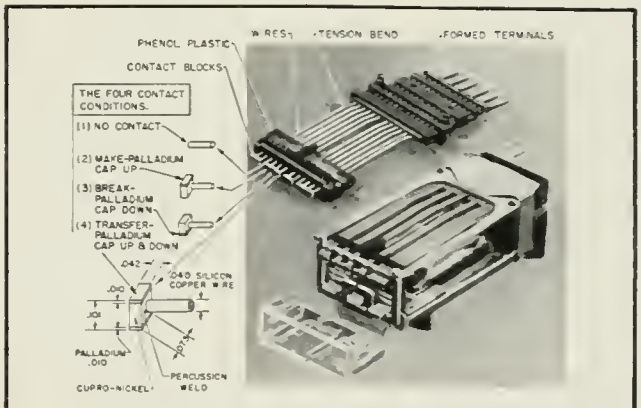
Longer life, higher operating speed, lower power consumption, and lower manufacturing cost were some of the advantages promised by the new relay design. Engineers reasoned that a lower manufacturing cost could be achieved through greater precision in manufacture (which would cut adjustments) and through extensive use of automatic processes.

One of the products of this reasoning is pictured at the top of this page. This battery of equipment, developed by Western Electric product engineers, constitutes one phase of wire spring relay manufacture, which automatically performs several separate operations. Its function begins after one of the fundamental elements of the new relay has been fabricated. This element, known as a "comb," consists of a multiplicity of small diameter wires in parallel array imbedded for part of their length in molded phenol plastic.

These molded elements, of which there are two types used in the new relay, are delivered to this line of machine units in magazines. By fully automatic means they are removed from the magazine, carried by a reciprocating conveyor through each of the several processes and, when completed, placed into another magazine to await further assembly.

Between the first and final magazine the automatic battery of equipment does the following operations: clips wire ends, attaches palladium contacts to wire ends by means of percussion welding, sizes contacts, forms terminal, tension bends wires, fluxes and tins terminals.

Most remarkable of all is the fact that this is a *precision* operation throughout. For example, the small block contacts, which are percussion welded to the tips of wires of one type of "comb," must be located on the same plane across the twelve contact positions to within a tolerance of ± .002".



Single Wire Comb with Percussion Welded Contacts, Wire Spring Relay Designed by Bell Telephone Laboratories

One type of "comb" element is shown at top while a completed wire spring relay is below. The small blocks of metal on the ends of the wires are cut from a composite tape during the automatic multiple percussion welding operation. "Contact conditions" are determined by the code of relay being manufactured and may vary greatly.

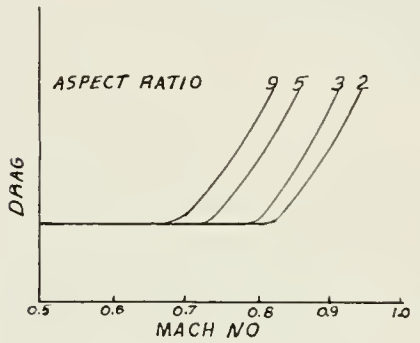
Western Electric

MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

Manufacturing plants in Chicago, Ill.; Kearny, N. J.; Baltimore, Md.; Indianapolis, Ind.; Allentown and Laureldale, Pa.; Burlington, Greensboro and Winston-Salem, N. C.; Buffalo, N. Y.; Haverhill and Lawrence, Mass.; Lincoln, Neb.; St. Paul and Duluth, Minn. Distributing Centers in 29 cities and Installation headquarters in 15 cities. Company headquarters, 195 Broadway, New York City.

section. His cockpit comprising the fin leading edge.

The glider was to be carried aloft and launched from the back of a Siebel Si 204 light transport at 25,000 feet. It was to carry water tanks to provide trim changes and a rocket motor to be used for high speed diving. The Nazis, however, did not have time prior to the close of the war to make tests with the glider. The captured design so interested the United States, though, that the glider was ordered completed and brought stateside. Immediate development of delta-winger aircraft was begun by several United States manufacturers in conjunction with the associated government agencies.

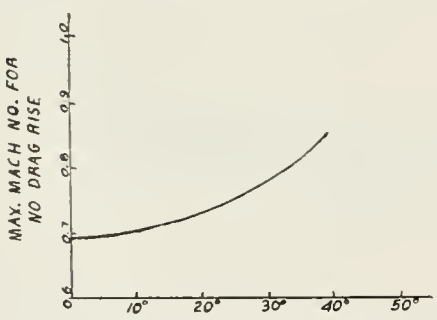


EFFECT OF ASPECT RATIO OF WING ON DRAG AT HIGH MACH NOS

Dr. Lippisch's experiments, upon capture, were not the only German research projects that aided the Allies in the development of supersonic aircraft. The German's had deduced that the major problems involved in the attainment of Mach 1 were drag reduction and provision of lift. But since dynamic pressures at supersonic speeds are so great, lift coefficients need not be large. This phase was laid aside in favor of the more serious difficulty of drag reduction.

The Germans provided two answers to this problem, wing sweep and low aspect ratio. Both of these pointed the way to the delta.

When an airplane is designed it is designed to carry the greatest payload (bombs, missiles, passengers, cargo) for the greatest distance at highest speed for the *least expenditure of fuel*. This fuel problem is quite intricate when you look below the surface. The less fuel you burn the less you have to carry. In this consideration you achieve an equilibrium between "less fuel" and "more payload." Also the less fuel you are pushing through your engines the longer your engine life. If in flight you run across a barrier where you must really cannonball your engines you (1) lose engine efficiency; (2) eat up fuel; (3) place a strain on your engines and; (4) place a strain on your airframe. Such a barrier is the sound barrier. Only the cannonballing doesn't begin at Mach 0.99. It may begin at Mach 0.6 or 0.7. This depends on the type aircraft and the drag induced by it.



EFFECT OF SWEEP WING ON MACH NO. FOR NO DRAG RISE

At present the theory of design is not to build an aircraft that will strain up to and then smash through the sound barrier but to build one that will maintain normal flight as close up to the sound barrier as it can and then push through it.

Following this thinking and the theories of the Germans, J. R. Evans, chief aerodynamicist of Britain's A. V. Roe and Co. Ltd. of Manchester, believes that it is possible to hold the drag rise till the region of Mach 0.9. According to him this is likely to be the Mach number for transport aircraft of all types for sometime to come.

Following are four ways to improve the high Mach number of behavior of the wing.

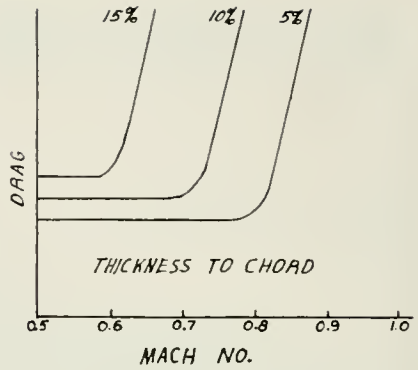
I. Wing Sweep:

As an aircraft flies fast it encounters a shock wave that forms a narrowing cone. According to Dr. von Karman, director of the Daniel Guggenheim school of Aeronautics at the California Institute of Technology, all action is restricted to the interior of this cone. The Delta, because its wings can be set back considerably, fits into this zone of action much like a finger in a glove.

II. Thinness:

By keeping the wing thin the amount of air that must be pushed out of the way of the airfoil is reduced easing its passage through the medium. The delta-wing planform leads to a very stiff structure without the use of thick wing skins, strength becoming the determining factor rather than structural stiffness, thus avoiding the inefficiency of conventional swept surfaces which have to be excessively strong and thereby thick in order to obtain necessary torsional stiffness and diminishing aer-elastic distortion at high speeds and their effect on stability or control power.

Thickness-to-chord ratio in the past has ranged from 21% to 12%, now delta ratios are common at 10%-7% and less.



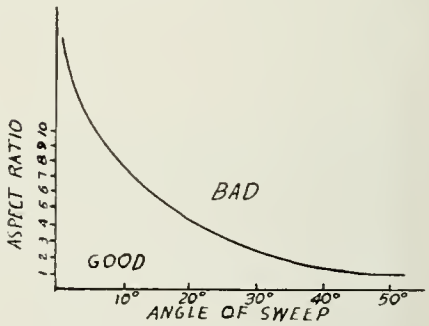
III. Low Wing Loading:

Mach drag effects are delayed by keeping wing loading as low as possible by supporting the aircraft weight with a large wing area. This is particularly important for high altitude flight, where the low air density puts a premium on keeping wing loading low.

IV. Low Aspect Ratio:

For moderate speeds, a high aspect ratio (large span relative to the chord) gives greatest efficiency. This consideration, however, is no longer important at high Mach numbers. Some alleviation of compressibility effects, it is held, is obtained by reducing aspect ratio.

One of the disadvantages of wing sweep is that flying characteristics at low speed become poor. A typical symptom is that the tip of the sweptback wing stalls, giving violent behavior if the speed falls too low.



ASPECT RATIO VS. SWEEPBACK FOR STABILITY AT THE STALL

However, research has shown that this bad characteristic can be overcome easily by using a correct aspect ratio.

Extensive wind tunnel and flight tests have shown that the low aspect ratio delta wing gives minimum change in stability and control characteristics at speeds near sound.

Reviewing the four points for displacement of drag rise there comes to mind just one type of airframe that incorporates these features in its basic design, the delta wing. The delta is highly sweptback, can be made very thin and wing loading and aspect ratio are naturally low.

A further point in the lowering of

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Oregon State College, B.S.,M.E.—1950

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"Our experience shows what *can* happen if you work with people open to suggestion. We found men of this kind at Allis-Chalmers, and it has given us a special pleasure in our job.

"We started out like most other graduates with a hazy idea of what we wanted to do. After working in several departments, we requested that part of our training be at the Boston Works of Allis-Chalmers, where circuit breakers are made."

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"Circuit breakers soon became an obsession with us, and we got the idea of designing a hydraulic operator and triggering mechanism for these breakers. Most operators for big breakers are pneumatic.

"Unsuccessful attempts had been made in the past by all circuit breaker manufacturers to build hydraulic operators. The important thing is that no one at Allis-Chalmers said, 'Don't try it—it won't work.' "

Start New Era

"To make a long story short, our study of the problem led us to the hydraulic accumulator and high speed valves being used by the aircraft industry. These had not been available when earlier attempts were made to build a hydraulic operator. With these highly developed devices to work with, we were able to build an operator that combined the best features of pneumatic and hydraulic operation. We call it the *Pneu-draulic* operator. Engineers are saying it starts a new era in circuit breaker actuation.

"This fact is important to us, but it is even more important to know that Allis-Chalmers Graduate Training Course is full of opportunity . . . and as we found out, there's opportunity right from the start."

Pneu-draulic is an Allis-Chalmers Trademark.

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1. It's well established, having been started in 1904. A large percentage of the management group are graduates of the course.

2. The course offers a maximum of 24 months' training. Length and type of training is individually planned.

3. The graduate engineer may choose the kind of work he wants to do: design, engineering, research, production, sales, erection, service, etc.

4. He may choose the kind of power, processing, specialized equipment or industrial apparatus with which he will work, such as: steam or hydraulic, turbo-generators, circuit breakers, unit substations, transformers, motors, control pumps, kilns, coolers, rod and ball mills, crushers, vibrating screens, rectifiers, induction and dielectric heaters, grain mills, sifters, etc.

5. He will have individual attention and guidance in working out his training program.

6. The program has as its objective the right job for the right man. As he gets experience in different training locations he can alter his course of training to match changing interests.

For information watch for the Allis-Chalmers representative visiting your campus, or call an Allis-Chalmers district office, or write Graduate Training Section, Allis-Chalmers, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

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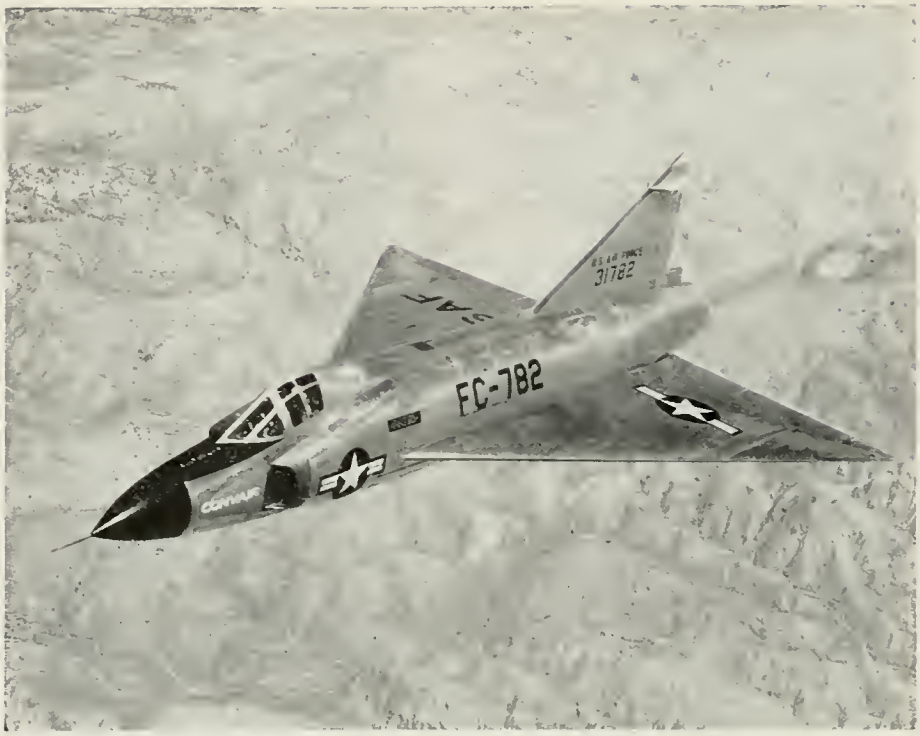


Convair has taken the leading role in the development of delta winged aircraft in this country.

drag is the fact that even though thin the delta's internal volume is large. This means that engines, landing gear, fuel and other necessary equipment can be contained within the wing and a rudimentary fuselage.

In addition to these low drag features the delta wing exhibits the unique characteristic of immunity to lift coefficient changes with changing Mach numbers.

The rectangular wing experiences a 20% increase in lift coefficients as Mach 1 is approached, an 80% increase as supersonic flow is established and a rapid deterioration of this lift with increasing Mach number until it has dropped 50% below its subsonic value at Mach 3.

In contrast the delta wing of low aspect ratio produces the same lift throughout this entire range from low sub-sonic to high supersonic speeds.

Mentioned before was the fact that the increased area of the delta wing would give a lower unit wing loading. This increase in area would seem to contradict itself as far as drag reduction is concerned. The drag induced by a wing is directly proportional to the surface area. The wing area itself does increase in the delta form but the horizontal surface area does not increase as much as it might seem. This is accounted for by the fact that the delta wing is inherently an aircraft with no horizontal tail surface. The horizontal stabilizer's job, that of preventing pitch in level flight, is done by the wing of the delta itself. The job of the elevators that of controlling pitch, is coupled with the job of the ailerons, controlling roll, and both jobs are done by control surfaces called elevons. The conventional vertical stabilizer and rudder are still used in the delta to control yaw.

All considered, the delta wing or some form of it appears to be the plane of the future for some time to come. Its flight stability, one of its many virtues, points out a better gun platform. Its outstanding speed and maneuverability point out a tremendous destructive power. Its all around ease of handling through and in supersonic speeds coupled with all its other fine points suggest that if not commercially adaptable, the delta will at least be the guardian angel or the devil of many, if not all, world air forces.

"To me," said one, "he's a pain in the neck."

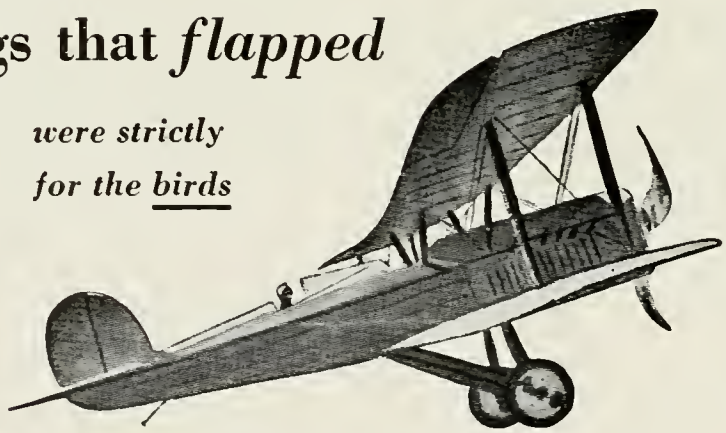
"Funny," said the other, "I had a much lower opinion of him."

* * *

Then there were the two little ink drops who were very blue because their pappy was still in the pen finishing out a sentence.

Wings that *flapped*

were strictly for the birds



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A motion-sound picture depicting high points in manufacture and use of Fafnir Ball Bearings is available to engineering classes. Write to The Fafnir Bearing Company for details.

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How the world's first atomic sub was welded

Welding the hull of the USS Nautilus, world's first atomic submarine, presented a tough problem.

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Worthington's answer to General Dynamics Corporation's Electric Boat Division, builder of the Nautilus, was the largest turning roll ever built.

The result? Welding of the Nautilus hull was accomplished in record-breaking time — and cost less than originally estimated. Unchanged, the Worthington roll set-up is also being used in the construction of the nation's second atomic sub, the USS Sea Wolf.

Turning rolls for submarines aren't all that Worthington makes. The long list of Worthington-designed, Worthington-built equipment includes air conditioning units, construction machinery, compressors, Diesel engines, steam power equipment and, of course, pumps of all kinds. For the complete story of how you can fit into the Worthington picture, write F. F. Thompson, Manager, Personnel and Training, Worthington Corporation, Harrison, New Jersey. You may be glad you did.

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Sand Castings

by Paul Davis, I. E. '56

Much ado is given to the study of various meanings of words in the classical study of logic. An example of the ambiguity of words is found in the phrase "sand casting." To one not familiar with technical terms this phrase might mean the action of throwing the common grains of sand that one might ordinarily find on a beach.

Assuming that your knowledge of throwing sand is sufficiently complete, let us give you some ideas about the technical meaning of sand casting here in our country.

Generally speaking, sand casting is the process of forming patterns or molds of sand and pouring molten metal into these forms. This allows the liquid metal to assume the predetermined shape i.e. that of the mold; when the metal has hardened the sand readily can be removed, leaving the desired form. It can be seen that a great number of things can and are being made by the process.

In a manner of speaking, foundries had their beginning in blacksmith shops of old. The art of forging with tongs, bellows and hammer goes back to Egyptian times. And perhaps the greatest discovery of the transition from the stone to the iron age was that of Damascus steel. Iron and steel then moved onward towards the goals of that age. If forms of armor, arms and so forth spread through the Middle East and up through France and across the channel to England.

It was in England that the idea of foundries took permanent growing roots. By this time America was a young country and eager to accept any methods to help develop her resources fully.

For a long time the foundry was a dirty, smelly and hot place to work. But with the development of America the foundry developed into the modern plants and factories that General Motors, U. S. Steel and other large companies are proud of. This is not to say that small jobbing or custom foundries yet are undeveloped, for in fact, automotion has made it possible for any shop regardless of size to be a pleasant and efficient place to work.

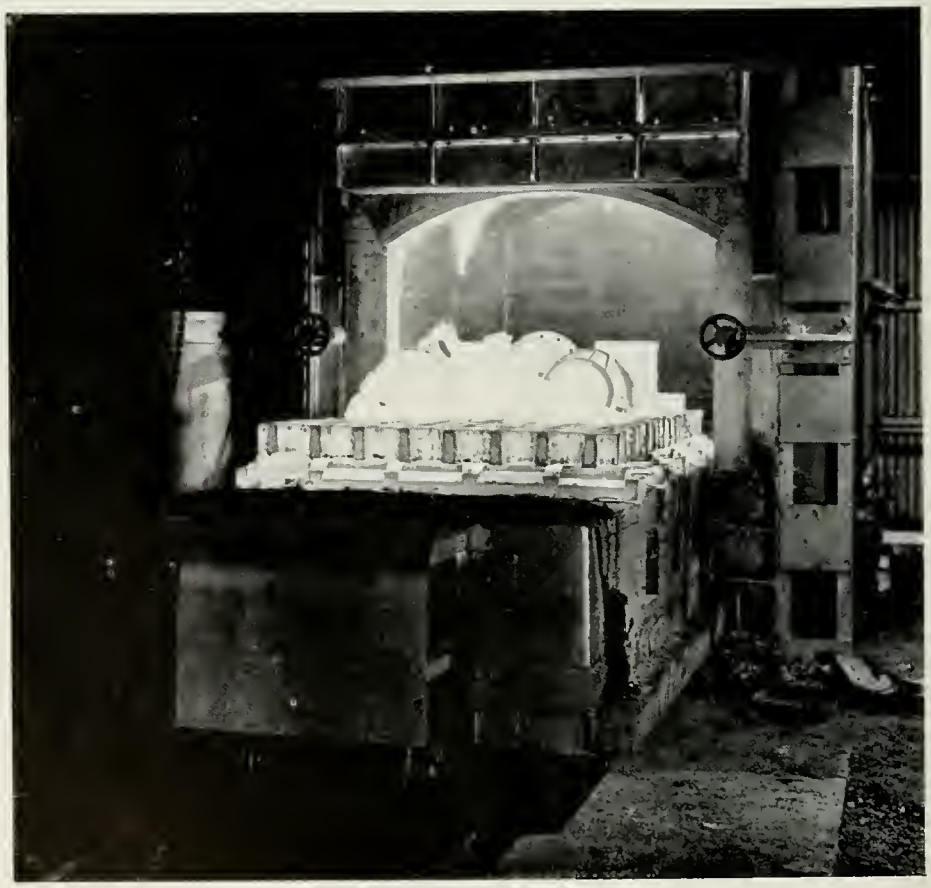
Automotion is the term used to describe the type of production that maximizes the resource fullness of men, their minds and their machines. That is to say that automotion brings into play the most possible productive power per dollar of cost. This calls for machines that can almost think and men who are capable of designing and operating these machines to their maximum efficiency. In the description of sand casting that follows, automation will be assured.

Sand and metal. These are the main constituents of the casting industry. Here again rises a question similar to the age old problem of the chicken or the egg. As to which is more important, sand or metal, it's hard to say. Let us assume that the beginning of our cycle is sand.

The type of sand depends entirely upon its use. It is used as backing or facing sand i.e. the body or skin respectively of the mold. It can be used as either the mold itself or as cones inside the mold which cause openings of desired shape in the castings. Naturally, the type of metal to be poured has a great deal to do with the type of sand. That it to say, when pouring high temperature metals such as steels and alloys, we need a stronger mold than when pouring metals that melt at much lower temperatures. In general, the sand used is one of the various combinations of sand, binder and water. The binder may be of a clay, oil or cereal type. Each particular characteristic sand type for a specific purpose.

The sand is received into the plant by boxcar or truck. The binder arrives in smaller amounts and the water comes via plant facilities. After receiving, the sand and its components are combined according to the properties desired. This is done in a muller, a huge mixing machine.

The sand, with a constant water content, then is moved by conveyers up



These hot castings are going into the furnace to be annealed.

to a temperature controlled room. From the storage room the sand is taken by conveyers to the various overhead hoppers which are directly above each molding station.

The two main parts of a molding station are a man and a machine. The man's qualities may range from semi-skilled to skilled laborer, depending upon the complexity of the machine.

Automation machines are able to do a great number of complicated tasks. In general, the operator reaches up and releases the mechanism that allows the proper amount of sand to fall into the flask which fits on the machine. The flask is no more than a wooden or metal form, generally rectangular, into which sand is packed around the pattern of the desired casting. The machine then packs the sand to the right strength around the pattern. Now some machines, just like people, do a better job than others. They may pack the sand, remove the pattern, roll the whole flask over to remove intricate patterns and other things that were heretofore done by hand. The flask with finished mold then is removed from the machine and the process repeats itself.

The completed mold must have the following characteristics in order to produce good castings: strength, porosity, collapsibility. Strength to withstand the force of the running hot metal. Porosity in order to allow gases formed to escape. Collapsibility to facilitate the easy removal of sand after the casting has The sand is capable of doing its particular job due to its combinations in various percentages with water and binder. After the sand has performed its important functions, the rest of the over-all operation is up to the metal itself.

The importance to the various jobs that metal can perform is so obvious and so lengthy that we refrain from reproducing it here. Let is suffice to say that our very lives as we know them today depend upon metal in some form. Just how well metal performs its various jobs is important to you as an individual.

A closer inspection will clearly reveal, however, that no one metal can do all the jobs that metals are expected and depended upon to do. This leads to the question: what metals do we have at our disposal generally to do the various distinct jobs that must be done?

The great variety of metals roughly is divided into two main divisions. Ferrous and nonferrous substances. These are the types of metals and their alloys that are used in foundries throughout the world. The name ferrous comes from Latin and it is symbolic of iron.

The first of the divisions in the ferrous group. Due to its size and variety this class is divided itself; even these divisions are large enough to allow further subdivision.

When a product is designed to do or perform a certain function, the designer always uses the metal that will give the maximum service. Along with service, cost of materials is an important consideration. Sometimes the cost and service are fairly well taken care of but the practibility of operation is out of phase with the situation. So there are three things that govern what metal should be used in a particular case: service of usefulness, cost, and practicability of manufacture.

After the type of metal is decided upon and the sand is ready, the process of casting actually begins. The metal is charged into the furnace of the type most suitable for the metal being used. Some furnaces in use are carbon arc (electrically operated) and the cuola, a coke oven. The metal is heated to the pouring temperature in the furnace. When it is ready the furnace is tapped into a waiting vehicle capable of transporting the molten metal to the spot where the metal is poured into the molds.

When the metal arrives it quickly is poured into the molds to form the desired shape.

After the metal has hardened the sand is removed and the casting is cleaned. The casting is removed at the shake out station. The sand goes to be prepared again or discarded. The casting is cooled and the adhesive sand removed by sand or air blasting. The casting then is taken to have its rough edges removed. After the final cleaning the casting is given its final inspection and prepared for shipment to the customer.

How Far Does the Dog Go?

Two pedestrians walk along the same road in the same direction. The first, walking at 4 miles an hour, starts out 8 miles in advance of the second, who walks at 6 miles an hour. As they start, the dog of one of them leaves his master and sets off for the other man at 15 miles an hour. As soon as he reaches the second man, the dog returns at once to his master, and so he continues to run back and forth until the second man overtakes the first.

How far did the dog travel?

Solution:

It will take the second man 4 hours to overtake the first. The dog, running at 15 miles per hour for this time, will travel 60 miles.

You are a dear, sweet girl
God bless you and keep you.
I wish I could afford to.

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Relocation of applicant must not cause disruption of an urgent military project.

Shot Peening

by Millard K. Darnall
Ag. E. '56

Although shot peening now has outgrown the experimental stage and is being used extensively on many types of parts and structures, it is a relative new process of lengthening the life of metal. This method is approximately seventeen years old. The Theoretical and Applied Mechanics Department here at Illinois was one of the first to do any experimenting with it.

Shot peening is the name for the process of striking the surface of structural metals and metal machine parts with small metallic shot by an air blast or rotating blade. The shot causes a deformation in the crystalline structure of a shallow layer of the metal. The crystalline structure of the shallow layer on the surface is cold-worked and the metal in this zone is strengthened.

The shot also creates a series of shallow spherical indentations which act as very mild "stress raiser." Shot peening sets up longitudinal and transverse compressive residual stresses in the surface layer also. These residual stresses add resistance to tensile stresses set up by direct loads and bending moments.

The shot used in this process is made of chilled iron and is spherical in shape. The shot is made by allowing drops of molten iron to fall into water. Then the shot is screened according to size. The diameter of the shot commonly ranges from 0.016 inch to 0.066 inch. The sizes of the short are designated by numbers. No. 28, for example, is smaller than No. 19.

Fatigue strength of metals may be measured from S-N diagrams in which results of a series of tests of specimens of structural or machine parts are plotted with values of stress (S) as ordinates and number of cycles of stress required to cause cracking or fracture (N) as abscissas. N is plotted to a logarithmic scale. Figure A shows typical S-N diagram of reversed bending tests of (1) a hot-rolled low-carbon steel, and (2) an alloy steel heat treated and then carburized. The specimens were approximately 0.300 inch in diameter. The strengthening effect of shot peening was greatest for long endurance, while for less than about 10,000 cycles of reversed bending there was very little gain in fatigue strength due either to polishing or shot peening. This may be partially explained by the fact that the yield strength was approached and the residual compressive stresses set up by shot peening were removed by repeated cycles of stress. Shot peening is not very effective in increasing the fatigue strength of a specimen or a part under direct axial stress.

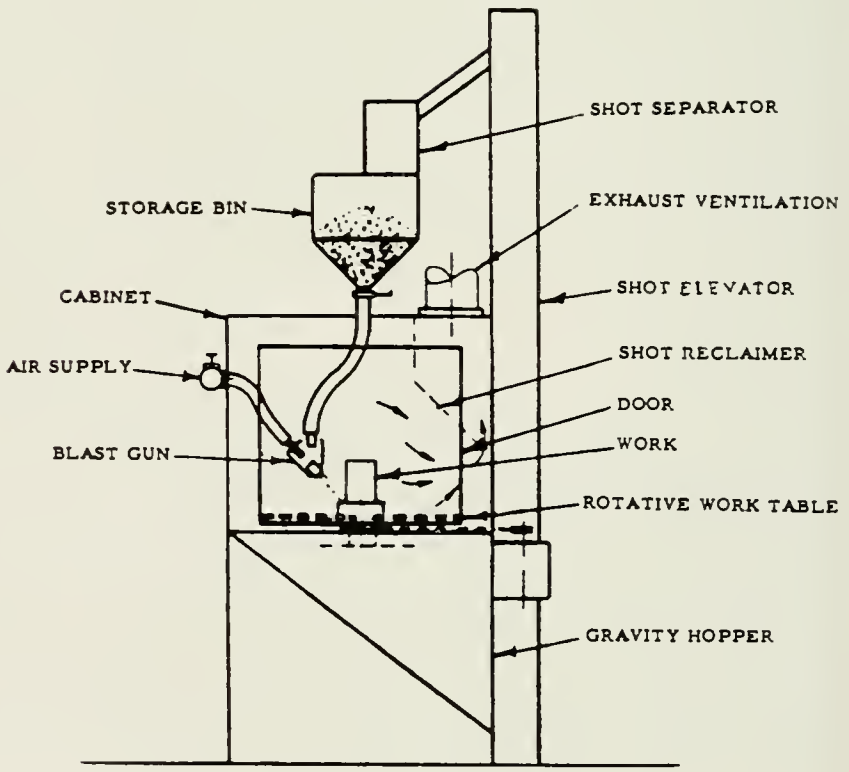
Shot peening is done by two types of machines: air blast machines and centrifugal blast machines. They both have essentially the same parts and the only difference is in the manner of which the shot is applied. Below is a schematic drawing of an air blast machine. The part which is to be peened is drawn slowly through the machine or slowly turned so the shot is applied evenly.

Many of the shot may break and these have to be separated. If the base of the minute holes formed by the shot is pointed instead of very smooth, the effectiveness of the peening is lost as the ultimate strength will be reduced in that area. Broken shot will cause these uneven bases.

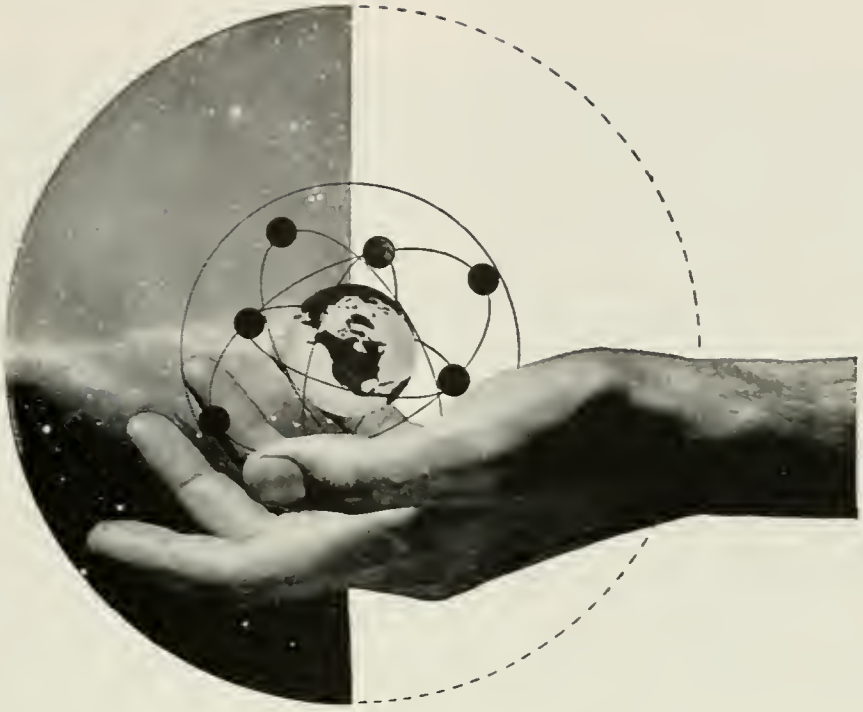
Shot peening cannot be used effectively to help increase the resistance to fatigue of materials with every kind of stress applied to them. Where the damage is due to elastic deformation, shot peening is not used because it does not change the modulus of elasticity of the metal by a great amount. Stiffness in metal is measured by the modulus of elasticity, therefore the stiffness of a member would not be increased enough to make it worth while to shot peen the member.

Shot peening would not help prevent elastic buckling of posts or large columns because the buckling occurs within the elastic range. When a member buckles after it has exceeded its elastic range it is called plastic deformation. Shot peening increases the resistance to plastic deformation (yield surface of the metal is made harder. The case of plastic deformation occurs in bolts which become loose after they have been loaded beyond the elastic limit. This load stretches the bolts more than they can contract. The machine parts do not expand as the bolts do, therefore the bolts are loosened.

Fracture is another form of fatigue in metals for which shot peening is used very satisfactorily. Fracture of metals is a continuous process which starts with a very minute crack. This crack is due to the exhaustion of the ductility of material. The stress at a



TYPICAL GRAVITY - INDUCTION PEENING MACHINE



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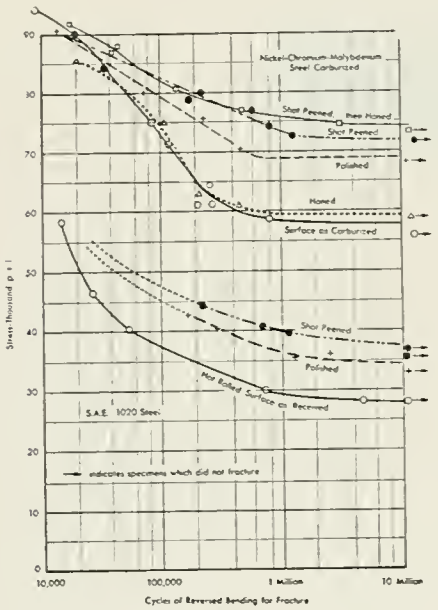
sharp edge of an object or the critical point, is larger than at any other point of the piece of metal. The concentrated stress causes the crack to increase which in turn increases the stress. The shot peened metal is covered with a compressed layer which prevents the formation of tensile cracks. Cracks cannot start in or propogate into a compressed layer.

Now that shot peening has outgrown its experimental stage, the list of parts which are being successfully shot peened is endless and constantly expanding.



Cycles of reversed bending for fracture.

Probably the best known and most widely used shot peened part is a compression coil spring. Springs made of wire sizes ranging from one-sixteenth to two and one half inches in diameter have been successfully shot peened. Shot peening has been found useful in torsion bar springs, especially if they are preset to increase their ability to carry a load without taking a set. It has been found that shot peening should be accomplished before the presetting.

When an even longer fatigue life of springs is required than can be obtained by conventional shot peening, stress peening can be applied. The spring then is shot peened in a partially loaded condition. This produces an even higher residual compressive stress than can be obtained normally. Stress peening also is frequently applied to coil springs.

Other parts which now are shot peened are: leaf springs (usually just on tension side), oil well drill pipes (can be done on the inside or on the outside or on both sides), axles (the spleened end), gears (fillets on the root of the gear), connecting rods, crankshafts, and exhaust stacks.

An Engineer Goes Thru . . .

HELL

Three men—a lawyer, a doctor, and an engineer—appeared before St. Peter as he stood guarding the pearly gates.

The lawyer stepped forward—with confidence and assurance he proceeded to deliver an eloquent address which left St. Peter dazed and bewildered. Before the venerable Saint could recover, the lawyer quickly handed him a writ of mandamus, pushed him aside and strode through the open portals.

Next came the doctor. With impressive dignified bearing, he introduced himself: "I am Dr. Brown." St. Peter received him cordially. "I feel I know you, Dr. Brown. Many who preceded you said you sent them here before their time. Welcome to our city!"

The engineer, modest and diffident, had been standing in the background. He now stepped forward. "I am looking for a job," he said. St. Peter wearily shook his head. "I am sorry," he replied. "we have no work here for you. If you want a job you can go to Hell."

This response sounded familiar to the engineer and made him feel at home. "Very well," he said, "I have had hell all my life and I guess I can stand it better than the others."

St. Peter was puzzled. "Look here, young man, what are you?" "I am an engineer," was the reply. "Oh, yes," said St. Peter. "Do you belong to the Locomotive Brotherhood?" "No, I am sorry," the engineer responded apologetically, "I am a different kind of engineer." "I do not understand," said St. Peter, "what on earth do you do?"

The engineer recalled a definition and calmly replied: "I apply mathematical principles to the control of natural forces." This sounded meaningless to St. Peter and his temper got the best of him. "Young man," he said, "you can go to Hell with your mathematical principles and try your hand on some of the natural forces there!"

And it came to pass that strange reports began to reach St. Peter. The celestial denizens, who had amused themselves in the past by looking down upon the less fortunate creatures in the Inferno, commenced asking for transfers to that other domain.

The sounds of agony and suffering were stilled. Many new arrivals, after seeing both places, selected the nether regions for their permanent abode. Puzzled, St. Peter sent messengers to visit Hell and report back to him. They returned, all excited, and reported to St. Peter:

"That engineer you sent down there," said the messengers, "has completely transformed the place so that you would not know it now. He has harnessed the fiery furnaces for light and power. He has cooled the entire place with artificial refrigeration."

"He has drained the lakes of brimstone and has filled the air with cool perfumed breezes. He has flung bridges across the bottomless abyss and has bored tunnels through obsidian cliffs. He has created paved streets, gardens, parks and playgrounds, lakes, rivers and beautiful waterfalls.

"That engineer has gone through Hell and has made of it a realm of happiness, peace and industry."

Reprinted from News Letter of Association of Professional Engineers of the Province of Ontario, Canada.

MACHINES IN MOTHBALLS

The Air Force will mothball 110,000 of its present 120,000 production machines at termination of present contracts. Tools will be stored either near present users' plants or in government warehouses.

SHIPS IN SECTIONS

According to a publication in the Soviet shipping industry, the Russians have developed an entirely new method in general ship overhauling. After the ship is checked for needed repairs, it is "sectionalized," or cut into two and three-dimensional sections, then hoisted to machine shops on the shore where specialists cut out the parts to make repairs.

HOT WATER

Radioactive water is being used in paint research to measure moisture penetration of protective coatings. Paint concerns believe it might aid in the development of house paints.

BIG BUSINESS

One of the nation's largest steel firms expects to furnish about 600 tons of steel for each million dollars spent on toll roads.

A young hopeful wrote his first novel and submitted it to a great publishing house. He called it "Why Am I Living?" In a few days he received the following message from the publisher: "Under separate cover I am returning your novel "Why Am I Living?" The answer to that is simple. Because you didn't bring it in personally."

Techno-cutie of the Month...

—Photo by Dave Komvathy

February's Techno-cutie is Miss Jo Bellmar. Among Jo's mony campus activities ore the University Choir, Oratorical Society, and Sigma Alpho Iota (professianal music froternity). As a music education major, Miss Bellmar finds time for sports, hobbies, and science fictian. She enjoys league bowling, swimming and is a faithful football and basketball fan.

In the Homecoming Queen's court, Ja represented Miss Purdue. Among her quolifications ore the following:

Age: 20	Weight: 55 xqs units
Height: 152 xqs units	Tape Dimensions: 83—57.5—83 xqs units

This luscious brown hair, brown eyed girl is not officially attached at presstime.

A Preview of 1955 . . .

Engineering Open House

by Dick Chester, Met. E. '54, and Don Kesler, E. E. '56

For 363 days out of the year the campus north of Green Street is quiet and inhabited only by the engineering students. During the other two days of the year the engineering campus is filled with milling crowds of people, the purr of machinery, and the flickering of electrical apparatus. These two days represent the annual Engineering Open House.

It is during these two days that each engineering school and society opens its doors to the public. Each school tries to out do the others with displays of complicated apparatus that awe the crowds of spectators. The Open House offers displays in every type of engineering taught at Illinois. At this time the public may spend an educational day or two, wandering from one building to the other seeing hundreds of displays, which include everything from the making of delicate pottery in the Ceramic Building to the breaking of concrete cylinders in the Talbot Laboratory.

The Open House of 1955 will be held on Friday and Saturday, March 11 and 12. To the outsider only the surface of the Open House is visible. They do not see the hours of work which went into the planning and running of the Open House. Work on the Open House was started during the first semester by a small group of students and faculty. This working force has been growing in number constantly. By the time the Open House is in progress, this force will include almost every student and faculty member in the Engineering College.

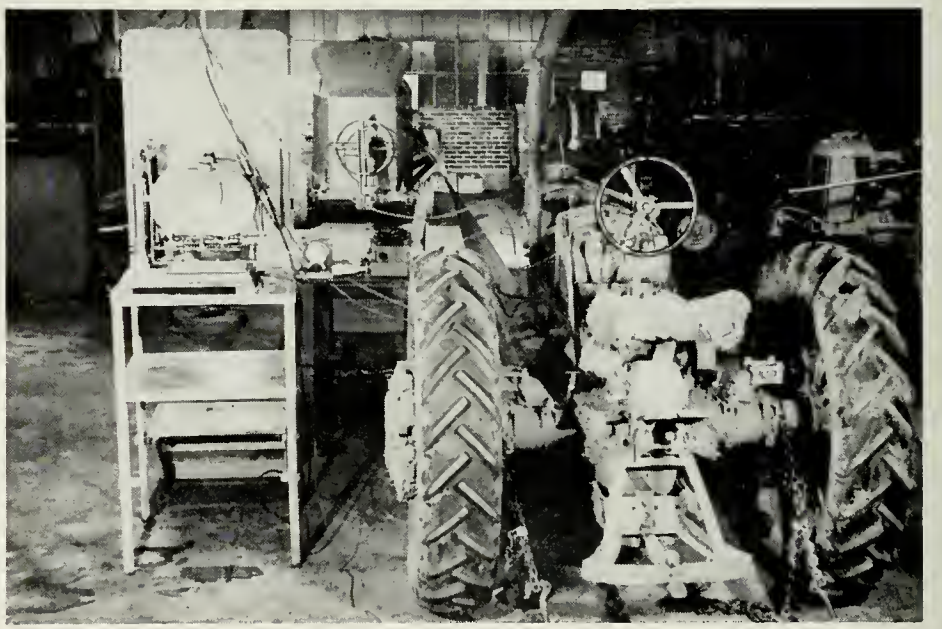
Work on the Open House was started by the general chairman, Dick Bemis, in September 1954. Dick appointed a group of students, each a chairman in a certain phase of the arrangements. Those appointed: Bruce Burgess, secretary-treasurer; Ken Padgett, program committee; Stan Freiberg, publicity; James McMahon, St. Pat's Ball; Robert Walker, physical arrangements.

These men worked together making the primary arrangements and laying the foundation for the vast amount of planning and co-ordination which went into the Open House. A number of students were appointed to each committee to assist the chairman in his numerous tasks. Right before Christmas a representative from each department joined the above mentioned group. These representatives worked together to co-ordinate the actual displays of each department into what the spectators will see as a well knit Open House.

The history of the Engineering Open House is a long and colorful one. The idea was first conceived by the Physics Department in 1906 when they held an exhibit. In 1907 the E. E. department picked up the idea, and in order to make money for a memorial to Robert Fulton, they staged a production. These productions were quite successful, and they were staged every year up into the thirties.

The first all - Engineering Open House was held in the spring of 1920. Another was held the following year, and they became a standard on the campus. They were held every two or four years until they were interrupted by World War II. The first Open House after the war was held on March 31-April 1 of 1950. The second one after the war was held on the week end of March 14, 1952. It was such a large success that it was decided to hold one every year. So now the Open House has become an annual affair on the campus.

The route for the Open House has been set up in the form of a circle. The spectators may start in any building, and



A view of the tractor laborotory showing a tractor ready to be tested on the dynamometer with other tractors and equipment in the background.

by following the route will be able to see all the exhibits without any repitition. The route and a list of the displays to be found in each building will be found in the Open House program.

For the benefit of the spectators, information desks will be set up at the entrance of every building. Lunch stands will also be operated for those attending the Open House who are not on diets. Many other services have been arranged for the benefit of the public.

Some of the outstanding exhibits to be found in each of the buildings are as follows:

Metallurgy Laboratory — Here you will be able to see the fabrication of metals into useful forms. Films will be shown which carry the metal from the ore stage to the forms used by everyone. They will show the many processes used in the extraction of the metal from the ore, and the fabrication of these metals into useful forms.

In the furnace room, metals will be melted and cast into ingots. Also the effects of heat treating these metals will be demonstrated. Many devices used in the inspection of metals for impurities, flaws, and their constituents will be demonstrated.

Mining Laboratory — Scale models of various mining methods will be exhibited. Demonstrations will illustrate various ways in which ores are concentrated and separated from gangue material. There will also be a display of the important minerals found in this country. A tour will take you through some of the most modern mine ventilation equipment used in this country. This department has one of the noisest exhibits found in the Open House. It is the test for the explosibility of coal dust, flour, and sulfur.

Ceramic Engineering — A demonstration will show the steps used in the making of bricks. There will also be an exhibit depicting the values of porcelain enamels and demonstrations of enamel applicability. Steps in the making of dinnerware and some of the properties of ceramic whiteware will be shown. One exhibit will show the development of glass through research and engineering into verstaile material.

Railway Wheel Laboratory — Here you will see some of the tests made on railroad wheels in order to provide better service in the future.

Foundry—There will be demonstrations showing the making of sand molds, and the methods used in casting various metals. Cast iron will be poured many times throughout the day. There will also be samples of the castings distributed.

Talbot Laboratory — This is one of the most fascinating exhibits in the Open House. Many different types of materials will be tested as to their stresses and strains. The testing machine used is one of a capacity of 3,000,000 lbs. You will be able to see many different types of interesting demonstrations and experiments pertaining to the flow of liquids.

Transportation Building—This building will contain exhibits showing the methods used in making engineering drawing. One exhibit will contain over fifty different types of slide rules, and another display the nineteen patent drawings which "have changed civilization."

Physics Laboratory — This exhibit will be highlighted by a half-hour lecture and demonstration of some of the primary principles of physics. Two extensive displays will deal with polarized light and the modern physics of atomic and nuclear energies.

Chemical Engineering Building —There will be exhibits which deal with almost every branch of modern chemistry. One will show the diffusional properties of various elements by the use of radioactive tracers. An absorption tower will be operated to illustrate the principle of separation of two gases. Movies will be shown throughout the day.

Mechanical Engineering Laboratory —The mechanical laboratory will feature a cutaway model of a jet aircraft engine, apparatus for testing air conditioning systems, and a high altitude chamber. The Agricultural Engineering display will be held in this building. The exhibit will include displays of farm mechanization, rural electrification, and soil conservation. The tool design laboratory will have a display of tools and production plant layouts.

Aeronautical Engineering Laboratories—The wind tunnel will be in operation during the Open House to demonstrate lift, drag, and air flow. There will be cutaway models of various types of airplane engines.

This power unit is for one of the testing machines located in Talbot Laboratory. The stresses are supplied to the specimen through jack screws.

Electrical Engineering—This building will be filled with many interesting devices. There will be a real flying saucer, the simplest motor in the world, man-made lightning, and a TV camera and receiver setup. You will have a chance to match your wits against an electrical brain, and try your luck on the kissometer.

Civil Engineering—Here you will be able to see the part the civil engineer plays in the construction of the many buildings, roads, and bridges which we all use. There will be models and pictures of some of the famous feats of construction. The basic principles of surveying will be explained to you.

The Open House of 1955 will be a treat for everyone regardless of age. The displays will awe and please you. This will be a very enjoyable way to learn a little more about the great part that engineers play in our everyday life. There is no reason why everyone should not be able to spend an enjoyable and educational day at the Engineering Open House of 1955.

THE FACTS OF LIFE FOR YOUNG ENGINEERS

by W. T. Nichols, Monsanto Chemical Company

When Commencement is over, engineering graduates report for duty with a new employer with very little real understanding of what opportunities are open to them, what will be required of them and how they will have to behave in order to succeed in accordance with their ambitions. Too much is left to chance and circumstance. In most cases, a man has incurred obligations and responsibilities of a rather serious sort by the time he wakes up to the facts and is no longer very free to exercise discretion in choosing a path of personal development. Almost all engineering graduates work for a salary in commercial, industrial or government organizations. It is with this group that I shall deal in the remarks which follow and more particularly with the segment that works in industry.

Most of us never are entirely free, all our lives, to make just those choices that might suit us best at the time. We have to compromise all through life and since this is so, it is good to learn how to compromise constructively. The important thing, it seems to me, is to compromise consciously and in the light of the facts rather than blindly, being pushed around by circumstances. In the case of engineering graduates, this is especially important for the fact is that there is infinite variety in the kinds of opportunity open to men trained in the engineering discipline. In our very complex American economy, technical aspects have become so important that men with engineering training have invaded every area of corporate activity and have reached every echelon of corporate management, including the very top.

How should a young man go about the job of succeeding? This brings up, at once, the question—What is success? To different people it means different things. I have pointed out at some length, elsewhere, (1) that it is of paramount importance to know what you want out of life. Your idea of success may eventually mean more prestige than money, more comfort than position. Usually, a young man just embarking on a career thinks of success in terms of progress in his profession, advancement in a business organization, gaining a good reputation and the respect and admiration of his fellows. One of the most articulate engineers of all time was the late Wilyliam E. Wickenden. Some of his writings have been collected under the title "A Professional Guide for Junior Engineers" (2). These make fascinating reading for men just about to embark on a career. Says Dr. Wickenden, ". . . the young engineer must have as he enters upon his career, and certainly must develop consciously and progressively as he pursues his career, some very specific qualities. Some of these qualities are quite homely, some are quite rigorous. They include: Courage and integrity, a strong purpose and determination, a thirst for knowledge, imagination, sound judgment, accuracy of thought, instinct for economy, the habit of thinking back from effect to cause, aptitude for leadership, ingeniousness, and the capacity for hard work." As he discusses these qualities more fully it becomes very apparent that success by any definition is not really a matter of luck, though chance may sometimes be quite influential. Good management of your career is certainly a safer bet.

Engineering is an art and therefore must be learned by practice. A neophyte Bachelor of Science in Engineering is not an engineer, may his grades be ever so high. Actually, comparatively few engineering graduates spend their careers in professional engineering. Large numbers of graduates start out in assignments where there is little chance to learn the engineering art but where engineering training is useful and necessary. A great many such jobs are in production supervision and sales and there are many fine opportunities for men well adapted to these sorts of activities. For those most interested in the theoretical aspects of engineering, all kinds of splendid research opportunities are available. Where a man has strong leanings toward the application of theory to practice, engineering groups of several kinds offer all manner of chances to learn and practice the art of engineering. For those who feel deeply that they wish to learn the art of engineering, even though they may not expect to make a lifelong career in professional engineering, it is obviously wrong to start out in an assignment such that engineering knowledge quickly slips away and is forgotten.

It is important to realize that no one else is going to do your thinking for you. Your new employer knows no more about you than you know about him. He has probably classified you on the basis of a relatively brief interview. If he needs a man for production supervision or sales or research or engineering and you seem to fit, you may get the job, but such an assignment may not lead you in the direction you want to go. While an employer is naturally anxious to have you in a job you like and where you will be happy, he cannot read your mind. The primary responsibility for your progress will always be yours. If you wind up as a routine draftsman or a clerk when you could have handled much greater responsibilities, the blame cannot be placed on your employers. Even in big companies that have elaborate personnel organizations and plentiful training programs, the burden is on the man himself to find his kind of success and right path to his chosen goal.

Job satisfaction is important. No one can be truly happy or even fairly effective unless his job gives real satisfaction. There are two primary approaches. One is to find a worthwhile course of development that fits your characteristics. The other is to alter your characteristics to fit some worthwhile course of devel-

opment. In most cases, some of each is required. Early training and family environment are influential factors in determining personal characteristics. A boy brought up under certain circumstances may largely lack the ability to maintain warm personal relations with other people. Such a person might be most comfortable, if left to his own devices, if he works at a job in which he has little or no contact with others and in which he can succeed without the cooperation of others. It is important to realize that, increasingly, technical work involves team work. "Lone-wolf" assignments are rare. This means that, increasingly, engineers must develop skill in human relations.

There are people who are happiest and most satisfied when they have technical responsibility and authority, rather than supervisory responsibility and authority. Such a person might by choice or by accident devote his career to a relatively narrow field of engineering activity. For example, a man might become a *top authority* on a subject such as steam boilers or steam turbines or switch gear or underground water resources or fractional distillation or mine safety or soil structure or corrosion. It is not difficult to imagine the intense satisfaction and sense of accomplishment which a certain type of mind would derive from such high attainment. Great technical authority can be wielded by these technical experts and great technical responsibility assumed. Many men enjoy such a life almost without regard to the income aspects or organization position. As our economy increases in technical complexity, the more progressive companies are realizing how very valuable great technical expertness is and are much more inclined than they once were to reward it in terms of both money and organization stature. Thus, a young engineering graduate might well consider the advantages of this path of development. It is not easy to get started on such a career. Few men just out of school have any strong devotion to a relatively narrow field of engineering. They are much more likely to be curious about all phases and their eventual preference is strongly influenced by early experiences that are largely unplanned and uncontrolled. Opportunities to specialize generally come along later, if at all. There does seem to be a tendency for employers to work a man into a specialized field if the employee is technically competent and at the same time not strongly inclined toward managing the activities of others. As in many phases of business life, natural processes sometimes bring about happy arrangements but too much is usually left to accident.

At the other end of the scale is the kind of person whose tastes and inter-

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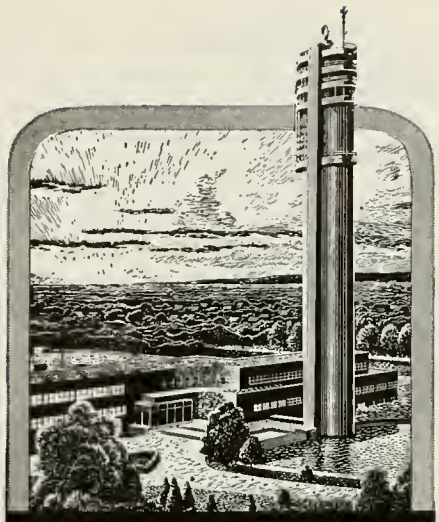

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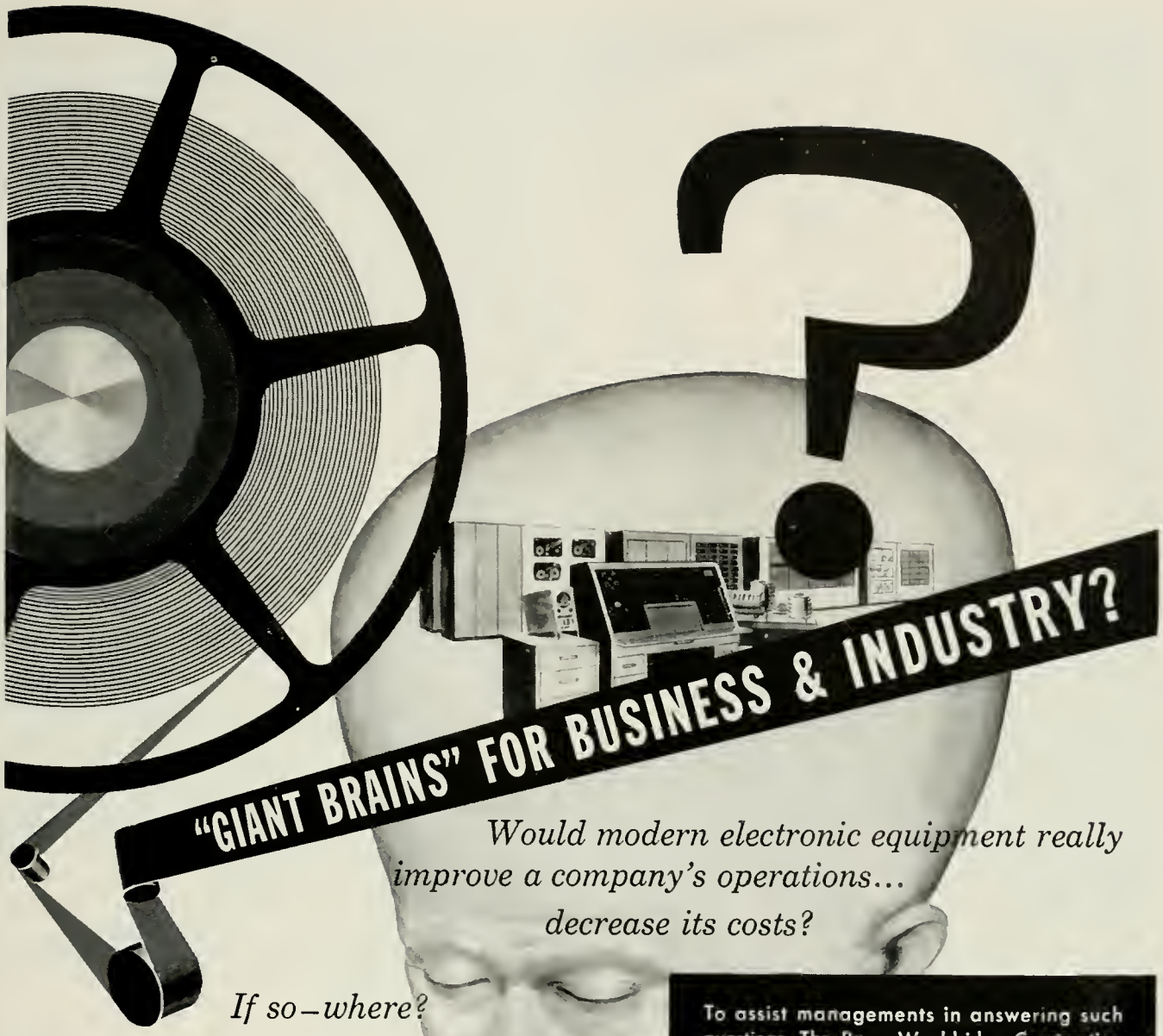
ests are catholic and who takes readily to the task of managing people and projects. Men who have real talent along these lines are eagerly sought by employers since the need is so great and because the financial consequences of good or inept management are so immediately and so strikingly apparent. It seems to be the case that only a very few men have well-developed management abilities in their early years and comparatively few ever develop these abilities of their own accord. There is great and rapidly increasing interest on the part of employers in methods for developing management talent. Generally speaking, the men who have been successful in the management line have attained very much higher remuneration and organization stature than those who have developed only along technical lines.

The great majority of engineering graduates have grown up in environments that produce neither the man strongly oriented toward lone-wolf, highly technical activity nor the born manager. Most engineering graduates fall in-between the extremes. A great deal depends upon how soon a man works under someone capable of developing his abilities and correcting his faults. Employers are showing evidence of much improved understanding and handling of these matters and opportunities for planned, on-the-job development of men to meet industry's needs are increasing rapidly for engineering graduates as for others.

While there is room for more and better engineering technical experts and always a great demand for engineering-trained management experts, the great majority of engineering graduates must find their careers in the area between these extremes. The reasons for any particular individual spending his working career exactly as he happens to do are usually pretty complex. Almost all men are naturally indolent. Only the exceptional men are willing to work really hard without any special prodding from outside. Consequently, it is easy to stand out from the great mass of employees if you are less indolent than the average. If you have average ability and work really hard, you can progress rapidly. A question of habit, rather than any deep-seated aversion from work, is involved. Any young engineering graduate who puts work ahead of everything else will move along much faster than those who do not. Social pressures are against this. Generally, it is much like school-days. The devoted student sometimes fears ridicule. The fact is that there is a kind of enjoyment to be had from intensive application to your work that must be experienced to be appreciated. It beats athletics or spectator sports or purely social events, although these are fine in their place. The rank assigned to work will usually determine your fate more than any other single decision. Distractions are plentiful in the form of recreational activities, attractive young ladies and the like. While these have their own importance in the scheme of things, improper emphasis may prevent or fatally delay advancement opportunities.

Engineering training is a great asset but certain characteristics that seem highly desirable in the engineering student can become obstacles to progress. Seldom do engineers have all the facts before it is necessary to make important decisions. The born engineer's strong desire is to be "logical" and factually correct at all times. He fears getting the "wrong answer" if not in possession of all the facts. Engineers in industry have to take intelligent risks or get left behind. Furthermore, our activities involve human relationships in which the factual or coldly "logical" approach is useless. Engineering training, per se, can furnish us with a basic understanding of physical science and its application to the work-a-day world but to make good use of engineering training to get things done we must learn those things which were called "The Unwritten Laws of Engineering" by General Electric's W. J. King (3). In that entertaining and enlightening dissertation the author states that in any engineering organization it could be observed that, "the chief obstacles to success of indivdual engineers or of the group comprising a unit were of a personal and administrative rather than a technical nature. It was apparent tht both the author and his associates were getting into much more trouble by violating the unwritten laws of professional conduct than by committing technical sins against the well-documented laws of science."

Exercise in higher mathematics is of unquestionable value in training the mind and in developing understanding of the evolution of engineering theory but the language of practical engineering is simple arithmetic. We are indebted to the theorists that this is so and engineering practice as we know it would be impossible if this were not true. Engineering graduates, with very few exceptions, deal with matters that require more or less technical knowledge but which invariably, for best results, involve the application of "horse-sense." This means that they frequently must develop alternate courses of action and make a choice that is reasonable in the light of the known facts and the probabilities of the situation. The most successful people seem to be those who can make the best use of engineering knowledge rather than those who know most about theory. Independence of thought is an oustanding attribute of a



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These multi-industry operations offer the college graduate many and varied types of careers in manufacturing, research, marketing, sales and administration.

PPG's record is one of continual growth throughout its more than 70 year history. Its operations are nationwide and in many foreign countries. Progressive policies assure unlimited opportunities for alert men who are looking ahead to more than "just a job."

PPG is seeking good men with college training. If you think you'd like to try your "grip" on one of the many PPG "irons," you're invited to write today for more information. Just address: Pittsburgh Plate Glass Company, General Personnel Director, One Gateway Center, Pittsburgh 22, Pennsylvania.

PAINTS · GLASS · CHEMICALS · BRUSHES · PLASTICS · FIBER GLASS

PITTSBURGH PLATE GLASS COMPANY

219 PLANTS, MERCHANDISING BRANCHES, AND SALES OFFICES LOCATED IN 250 CITIES

high-type engineer. Carried to unwise extremes, however, "independent thinking" may put a man so out of step with his organization that his efforts are fruitless. What seems to be independence of intellect may actually be merely inability to see and employ the viewpoints of others. So much industrial thinking and decision making depends upon group effort that it is necessary to make one's own thoughts fit in with those of others to get complex problems solved. For success and advancement in even the most highly professional branches of engineering employment development of leadership characteristics is necessary.

The graduating class in an engineering school comprises the survivors of a pretty selective process. Many have fallen by the wayside. Even so, the class will cover the entire gamut of academic accomplishment, from those whose grade-point average is near perfection to those who just squeak by. American industry is so complex that there are needs for all kinds of people who have the engineering background. In almost all jobs the man who learns how to be a good subordinate and a good teamworker, and how to make good decisions even though all the detailed facts are not available will get along much faster than the one who bogs down in detail because he is afraid of getting the wrong engineering answer in the absence of fully documented, precise data. Academic accomplishment is not the whole story behind success in engineering life. Comprehensive knowledge of engineering theory is a tremendous advantage and forms a firm foundation on which to build. Hard work leads to success and enjoyment. Identifying your goals and consciously working toward them is the best prescription for a happy life.

Recommended reading:

(1) Illusion of Success. W. T. Nichols. Chemical Engineering Progress. March 1947. (Reprint, 15c from E.C.-P.D.)

(2) A Professional Guide for Junior Engineers. W. E. Wickenden. Engineers Council for Professional Development. 64 pages, $1.00.

(3) The Unwritten Laws of Engineering. W. J. King. Mechanical Engineering, May, June, July 1944.

Pat went to pay his respects to his friend Mike, who had passed away suddenly. Standing at the head of the casket, with Mike's widow alongside, Pat remarked, "Doesn't he look wonderful?" "Why not?" said the widow with a shrug, "he was in Miami all winter!"

An engineering prof was lecturing his 8:00 class on the virtues of being wide awake.

"I've found that the best way to start a day is to exercise for five minutes afte rrising, breathe deeply, and finish with a cold shower. Then I feel rosy all over."

Just then a sleepy voice was heard to mutter from the back of the room, "Tell us more about Rosy."

* * *

Hotel clerk to prospective guest: "I'm sorry, but we don't have room service."

Guest: "Oh, that's all right."

Clerk: "You'll have to make your own bed."

Guest: "That all right."

Clerk: "You'll find hammer, saw, lumber, and nails in the back room."

* * *

The ministry is the only profession we know of where men really work to heat hell.

* * *

Plagiarism: Stealing from an author.

Research: Stealing from many authors.

"I just bought a skunk."

"Where are you going to keep him?"

"Under the bed."

"What about the awful smell?"

"He'll have to get used to it just like I did."

Help Wanted!

The Technograph needs men and women interested in gaining experience in:

- **BUSINESS PROCEDURES**
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213 Civil Engineering Hall

Sperry Gyroscope Co. Operates 12 Test Boxes with

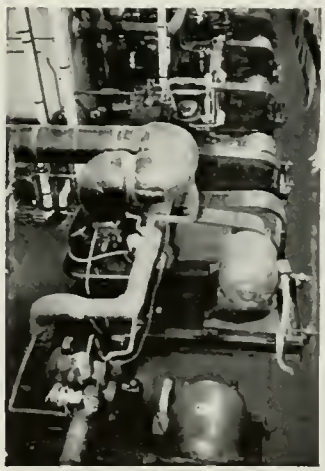
FRICK

Refrigeration

At the Great Neck, Long Island, plant of Sperry Co., a dozen environmental test chambers have been equipped with cooling and humidity control, operated by an elaborate low-temperature refrigerating system. This was designed and installed by Tenney Engineering, Inc., Union, N. J., using 14 Frick "ECLIPSE" compressors. Temperatures range from 100° below zero to 200° above.

Whatever your special cooling needs, there's a Frick air conditioning or refrigerating system to meet them with dependability. Let us submit an estimate: write, wire or phone—

Below: Six of the fourteen Frick "ECLIPSE" compressors installed in Sperry Engineering Test Department.



For a position with a future inquire about the Frick Graduate Training Course in Refrigeration and Air Conditioning. Operated over 30 years, it offers a career in a growing industry.

DEPENDABLE REFRIGERATION SINCE 1882

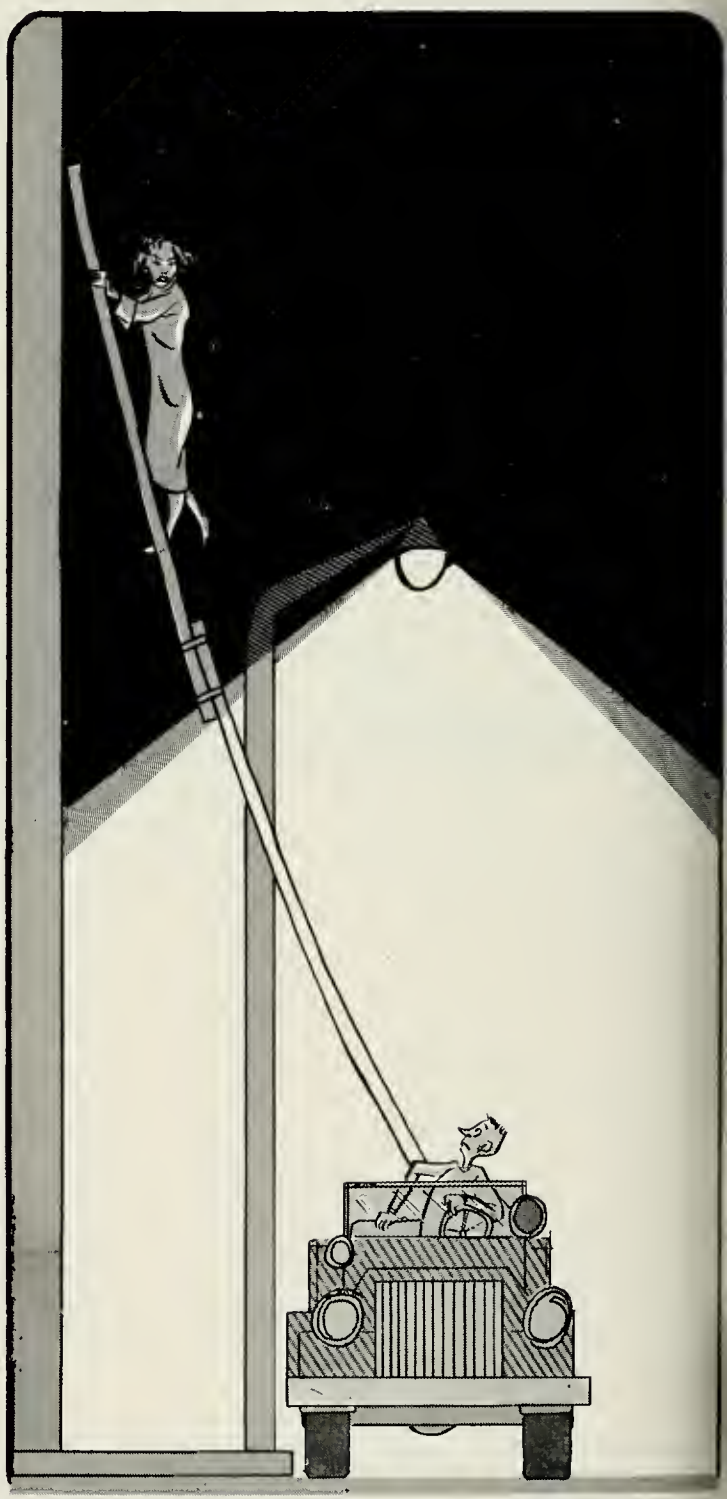
FRICK CO.

WAYNESBORO, PENNA. U.S.A.

CRENSHAW

WELL, WELL, WELL....GATHERING SOME IMFORMATION FOR THAT PH.D. THESIS, PROFESSOR GRUFF?

OH, I SEE YOU'VE MET OUR HOUSE-MOTHER.

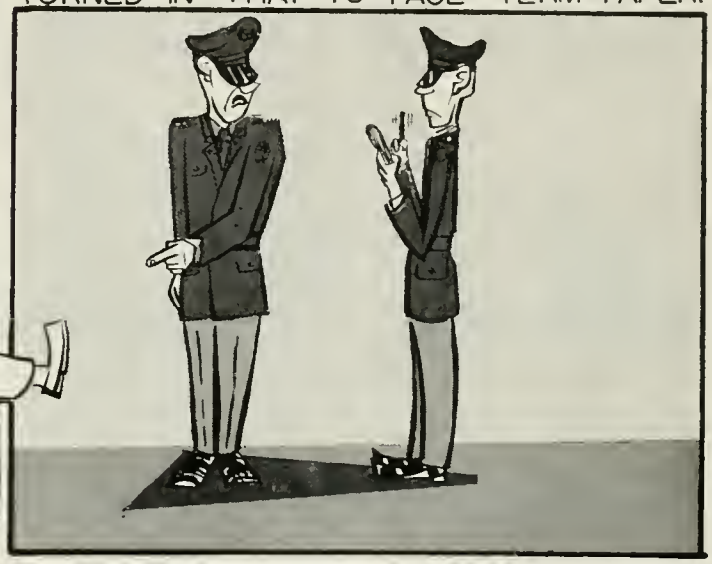


CRENSHAW, COULDN'T YOU HAVE THOUGHT OF A QUIETER WAY OF GETTING ME IN AFTER HOURS?

ON CAMPUS

by Dave Templeton

CRENSHAW, SOMEHOW YOU'VE JUST NEVER LOOKED THE SAME SINCE YOU TURNED IN THAT 75 PAGE TERM PAPER.



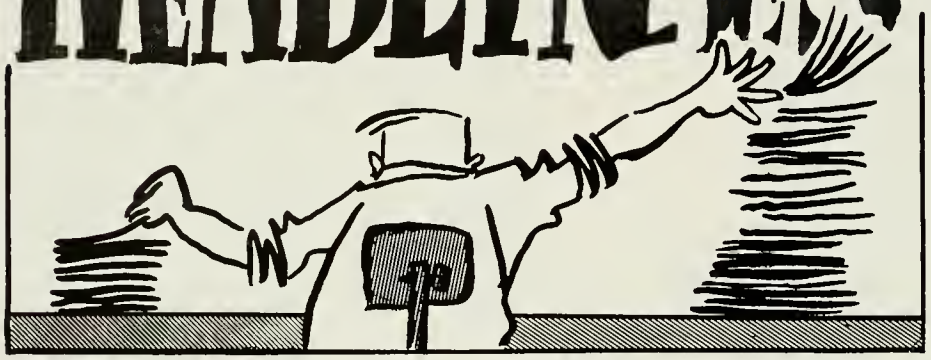
ONE DEMERIT! DIRT ON THE BOTTOM OF HIS SHOE!

U 'BOUT READY TO GO EAT, ENSHAW?

OR MISS FALSEBOTTOM...SHE'S BEEN THE MAIN REFERENCE ROOM FOR RTY YEARS- COULDN'T TAKE THE LENCE ANY LONGER.

WHY, I HAVE COMPLETE CONFIDENCE IN THE INTEGRETY OF MY STUDENTS DURING AN EXAM!

SKIMMING INDUSTRIAL HEADLINES



by Larry Kiefling, M. E. '56

Giant Transformers

These bushing-type current transformers are for a Westinghouse 330-kv breaker having an interrupting rating of 25 million kva. As many as 15 of these transformers will be mounted on a three-pole breaker. Never before has a three-pole breaker had to carry more than 12, nine being more common. Furthermore, three of these are used for revenue metering, and are unusually large to provide adequate cross-section of the case to insure the necessary accuracy. Each transformer is encased in Fosterite and contained in its own aluminum housing which protects it from damage during assembly as well as in service.

Transistors at Illinois

Transistors—the mighty mites of electronics—are moving into a new and complicated field which so far has been handled entirely by vacuum tubes of the ordinary radio receiver so-called "electronic brains."

Circuits to use transistors in these machines now are being studied at the University of Illinois by Robert A. Kudlich, graduate electrical engineering student.

The advantage of transistors over ordinary radio tubes is in their small size and low power consumption. Future computers using transistors may require only one-tenth the power of present-day machines.

The work is supported by the Office of Naval Research and an RCA Fellowship.

Circuits being studied by Kudlich are of the direct-coupled type suitable for asynchronous—self - timing—computing machines, of which the Illiac at Illinois is an advanced example. While most commercial machines today are of the synchronous type, many technical people feel that the asynchronous computers will be more important in the future.

Transistors, Magamps

Transistors are available only in watt sizes and admittedly are in the baby stage of development. Yet research engineers are doing things with them now, mostly in conjunction with magnetic amplifiers, that are hard for electronic or power engineers to believe. Many of these come from a fairly recently acquired concept. The concept that while the transistor alone is remarkable and is (with the magnetic amplifier) the key to it all, the things achieved by the new circuitry it makes possible are fantastic, particularly as larger capacity crystals become available.

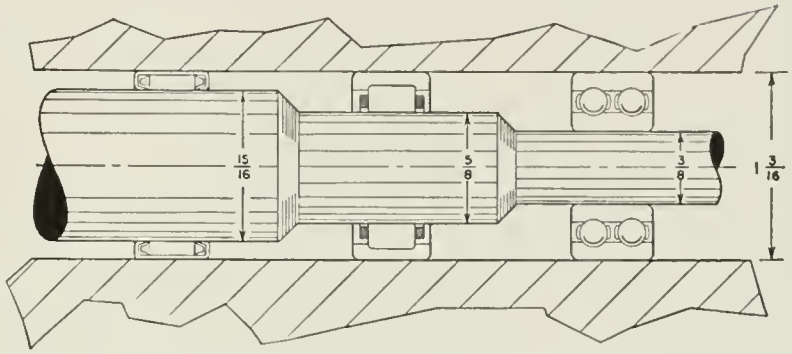
Transistors, in proper circuits, are being used as switches or relays. They make possible switches, completely static and with indefinite life, having an efficiency better than 90 per cent compared to the 50 per cent of a class-A amplifier stage.

A combination of transistors and Magamps can be used to create a time delay of any given length. And always the accuracy is to one cycle of the basic frequency used. For example, a delay, even of days or weeks, could be provided ac-

Fifteen of these transformers are used on a 25,000,000 kilovolt-ampere circuit breaker. The transformers can also be used for metering.

The Torrington Needle Bearing
is designed for high radial loads

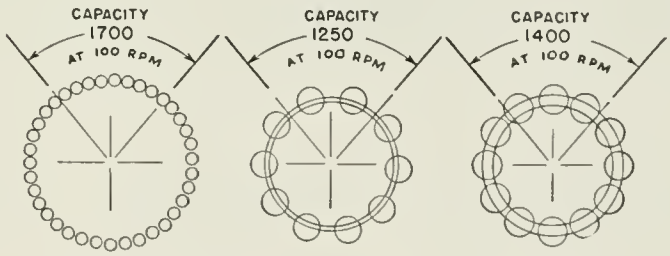
The many lineal inches of contact provided by the larger number of small diameter rollers give the Torrington Needle Bearing an unusually high load rating. In fact, a Needle Bearing has greater radial capacity in relation to its outside diameter than any other type of anti-friction bearing.



1. *Illustrates the fact that for a given housing bore size, a larger and, therefore, stiffer shaft can be used with Needle Bearings than with a roller or ball bearing.*

Precision Manufacture and Unique Design

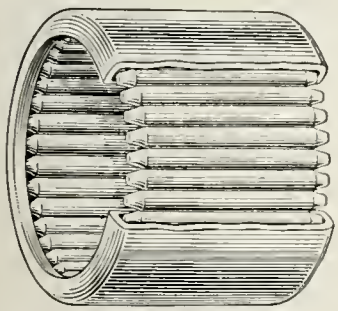
The exceptional load capacity of the Needle Bearing is the result of proper selection of steels, precision workmanship to close tolerances, and the application of modern anti-friction principles.



2. *Shows the greater number of lines of contact in the load zone of a Needle Bearing compared with a ball or roller bearing.*

The one-piece shell, which serves as the outer raceway and retains the rollers, is accurately drawn from carefully selected strip steel. After forming, it is carburized and hardened. There is no further grinding or other operation that might destroy the wear-resistant raceway surfaces. The full complement of thru-hardened, precision-ground rollers is retained by the turned-in lips of the one-piece shell.

The small cross section of the Needle Bearing allows a large shaft which permits a rigid design with minimum shaft deflection, a factor of utmost importance to good bearing design.



THE TORRINGTON COMPANY
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District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON NEEDLE BEARINGS

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • BALL • NEEDLE ROLLERS

curate to 1/60 of a second, if 60-cycle power is used. This same circuit can be used as a counter of events, as represented by pulses.

The old dream of a high-frequency d-c transformer becomes a reality. Transistors, in a relatively simple circuit, can convert direct current to a square wave. This, being alternating, can be changed in voltage and, by full-wave rectification, returned to direct current. Overall efficiencies for circuits delivering a few watts are about 90 per cent.

Indicating Mike

An indicating micrometer providing "visible feel" to the user and having a range from 0-1," reading in .0001" is announced by the George Scherr Company, Inc.

"Tenths" are easily and unmistakingly read from an extra large dial. The indicating mechanism controls the measuring pressure so that all uncertainties due to differences in "feel" of individuals are eliminated. The "Master Compar" indicating micrometer really offers what its name implies, namely a master-micrometer and a comparator combined in one instrument. In addition, this tool provides the user, due to its ingenious design, with a complete set of go and no go gages of one inch range, reading in .0001". A most important feature is that it detects out-of-roundness, ovalness and taper. The fact that the release button for the movable anvil is on the right hand side makes it a right hand tool, enabling the operator to hold it the conventional way.

Radically new is the resetting to zero which is accomplished by means of a screw on the bottom of the housing and can be done accurately in less than 5 seconds. Heavy tungsten carbide anvils and finished hardwood case are standard equipment. Larger sizes up to 4" are furnished with removable indicator. The price for the 1" size is $95.00.

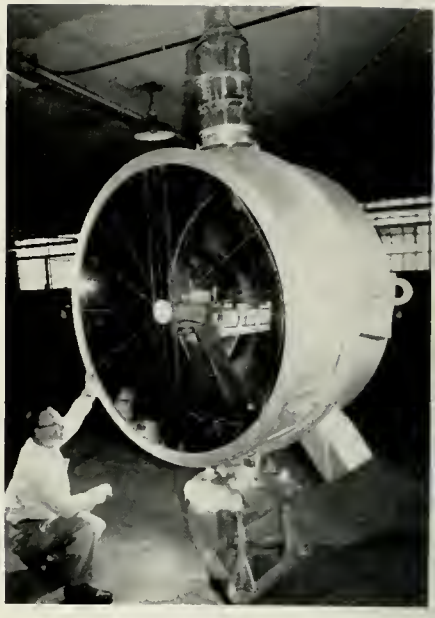
Giant Searchlight

One of the world's largest and brightest searchlights, capable of throwing its beam approximately 120 miles, has been shipped to Dallas, Texas.

The huge light, containing a 2500-watt short-arc mercury-vapor discharge lamp, will develop 275,000,000 candlepower. It has a reflector five feet in diameter, stands more than 11 feet high, and weighs 1200 pounds.

The unit was ordered by the Federal Sign Co. of Texas. It will be installed as an attention-drawing beacon atop the new 150-foot-high ornamental tower of the Republica National Bank Building in Dallas. When in place, the searchlight will be 598 feet above the street level.

Originally a carbon arc light used as an antiaircraft search light during World War II, the light was modified by the addition of a Westinghouse-developed mercury lamp and a rotating base constructed of aircraft steel and aluminum capable of withstanding 100-mile-an-hour gales. A small, one-sixth horsepower Westinghouse motor will drive the light as it revolves at a rate of 12 revolutions per minute from dusk to dawn.



This five foot diameter searchlight is used for advertising. It throws its beam for about 120 miles.

Attached to the top of the searchlight is a red aircraft warning beacon, lighted by two 500-watt incandescent lamps.

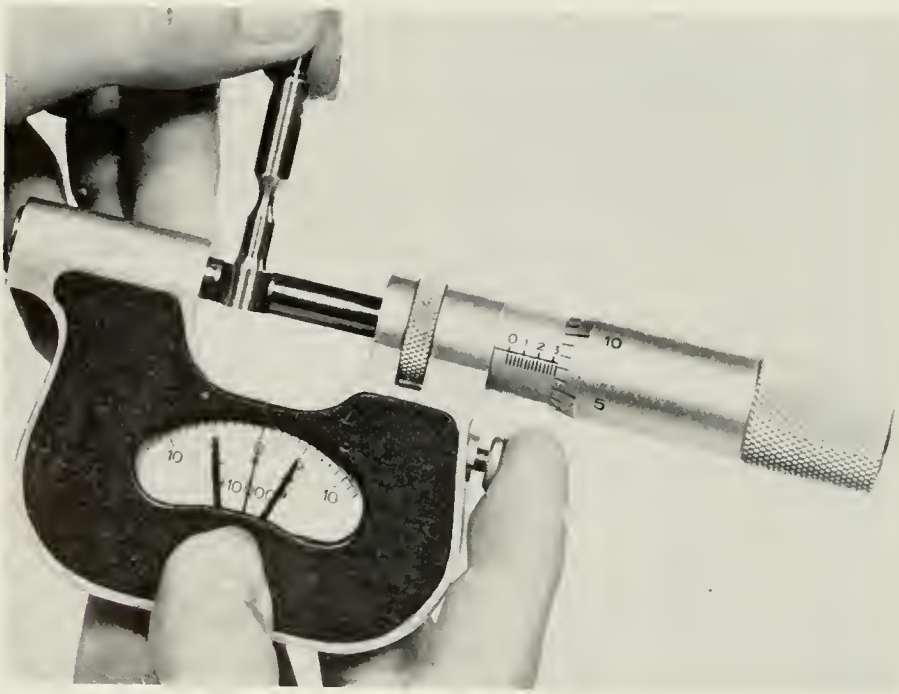
Gas Turbine Helicopters

Gas turbine engines will give helicopters twice the power of piston engines of comparable weight, Harold T. Hokanson of the General Electric Company told the American Helicopter Society recently.

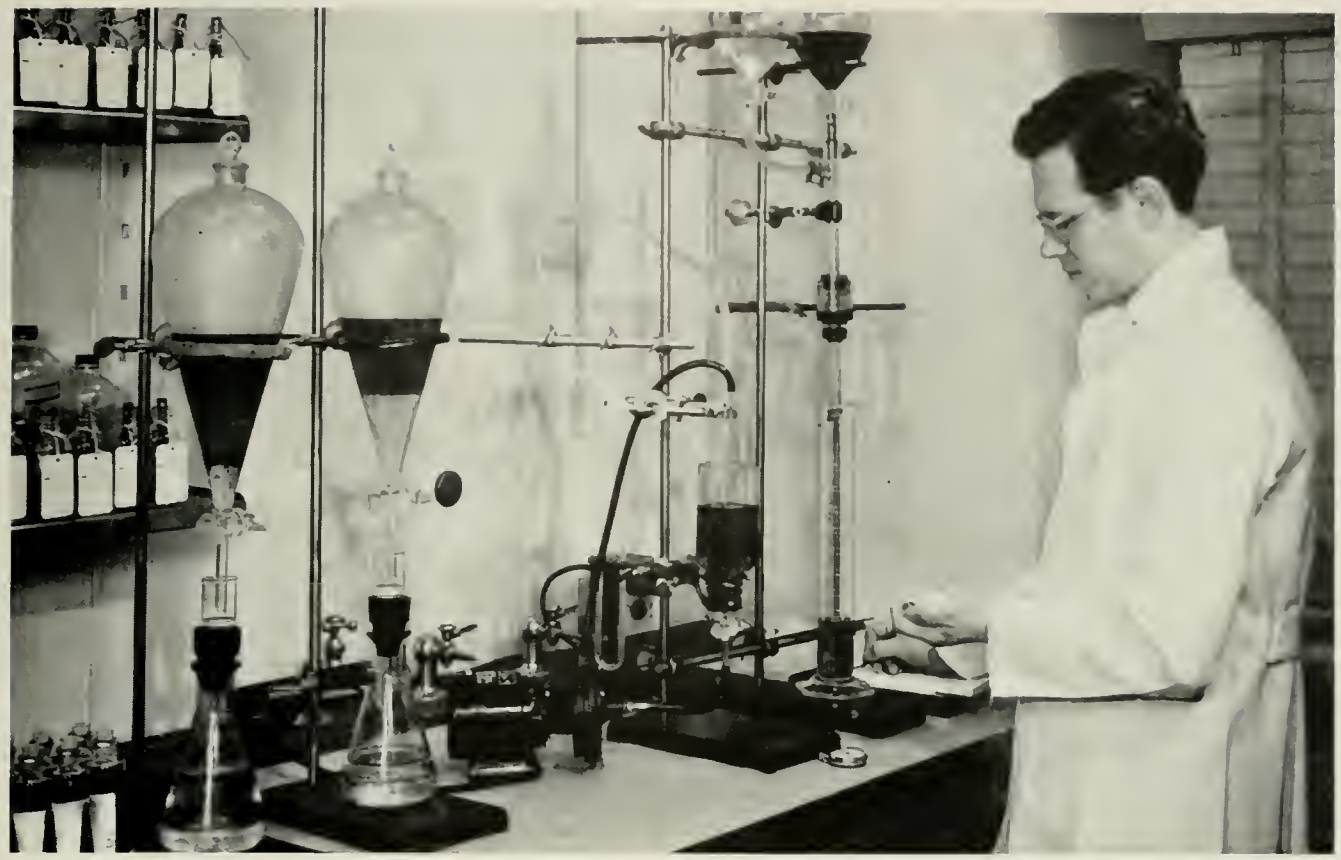
Mr. Hokanson, who is directing development of a Navy helicopter gas turbine engine at his company's small aircraft engine department, said weight to horsepower improvement is just one of the many reasons why gas turbines are "tailored to helicopter requirements."

Included in Hokanson's list of advantages were fuel economy, low noise level, durability, and reliability.

In discussing fuel consumption, he said that while the specific fuel consumption (pounds of fuel per horsepower hour) of a piston engine is roughly equivalent to a gas turbine engine in the major area of helicopter operation, the premium gasoline required by a piston engine cost two and half times as much as the gas turbine fuel. He pointed out that the reason why a piston engine does not show a great specific fuel consumption advantage is that a helicopter is unique among aircraft since most of its normal operation is at full or nearly full power. The S.F.C. of a piston engine increases at high power levels, while the S.F.C. of the gas turbine decreases as power increases and is



The indicating mechanism of this micrometer eliminates error due to differences in feel of individuals. Tenths of thousandths of an inch can be reod on the dial. (Photo courtesy George Scherr Co.)



To help develop STA-CLEAN for STANDARD Furnace Oil, the testing apparatus shown here was constructed. Running an experiment on the improved oil is Dr. Jack A. Williams, a chemist at Standard Oil's Whiting laboratories.

HOW TO SOLVE A BURNING PROBLEM!

Scientists in Standard Oil laboratories work with the stimulating knowledge that practical and valuable results will be obtained from their discoveries. A recent achievement of Standard Oil scientists is now benefiting hundreds of thousands of STANDARD Furnace Oil users throughout the Midwest.

In 1952 our research people undertook the problem of finding a method to eliminate oil burner failure or inefficiency arising from clogged filters and burner nozzles.

After months of painstaking laboratory work and many more months of thorough field testing throughout an entire heating season, Standard Oil scientists perfected a new, efficient additive—STA-CLEAN. Blended into our furnace oil, the new additive acts as a detergent, sludge inhibitor and rust stopper—all in one. STA-CLEAN assures clean oil filters and nozzles—a dramatic contribution to efficient and economical heating.

The development of this remarkable new additive is further proof of the progress possible when scientists are given time and equipment to explore and develop thoroughly their ideas. Young scientists find such an atmosphere inspiring.

Standard Oil Company

910 South Michigan Avenue, Chicago 80, Illinois

STANDARD

at its best at full power, he explained.

Because the turbine wheel attempts to extract every last bit of energy from the gas stream and convert it to shaft horsepower it has the effect of being a muffler. For this reason, Hokanson feels that a gas turbine engine will be less noisy than an equivalent piston engine.

He predicted that helicopter gas turbine engines would be reliable and durable. This prediction, he said, is based on General Electric's previous experience with jet engines, notably J47 engines. J47's in Korea averaged less than one engine removal, due to foreign object damage, for every one thousand hours of operation.

Again citing combat experience of the J47 gas turbine, Mr. Hokanson said that a gas turbine engine is a rugged and reliable piece of machinery. He said that J47's have accumulated operating time equivalent to 100,000 times around the world with an average of ten times around the world per major overhaul. "This kind of reliability can and should show equally startling results when gas turbine engines are powering helicopters," Mr. Hokanson explained.

The T-58 is a gas turbine engine for helicopters which is being developed for the Navy's Bureau of Aeronautics. It will be about the size of an automobile engine but many times as powerful.

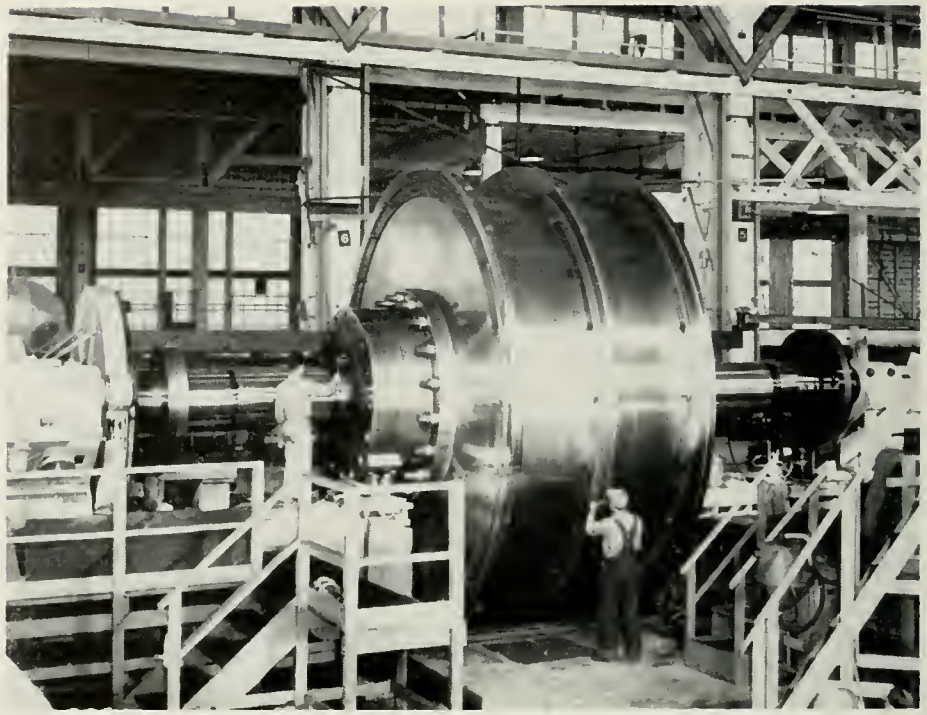
Mr. Hokanson explained that gas turbines for helicopters are similar to jet engines. Replace the tailcone on a jet engine with turbine wheel that can extract energy from the hot gas stream and you have a gas turbine that could power a helicopter, he said.

Primarily an air breathing engine, a hypothetical gas turbine rated at 1250 horsepower would breathe approximately 14 pounds of air per second or 10,400 cubic feet per minute. An average man in an average day breathes approximately one cubic foot of air per minute so it would take at least 10,000 people to blow the required hot air through the little one and one-half foot diameter turbine wheel of this engine for one minute of operation.

Typical compressor blade for such an engine would weigh about one-fifth of an ounce but it spins so fast during engine operation that it would feel as if it weighed one-half of a ton. The merry-go-round ride that it gets on a compressor wheel multiplies its weight about 75,000 times.

Largest Compressor Rotor

This 18-foot-diameter compressor now undergoing final tests, is the largest of its type ever built. It will be installed in the U. S. Air Force's new propulsion wind tunnel, Tullahoma, Tenn. Built at the Pacific Coast Manufacturing Plant of Westinghouse Electric Corporation, their compressor, plus four supersonic compressors, will be powered by a 216,000-hp single-shaft drive. The giant 130-ton rotor is made up of three giant discs separated by spacers. When the 1200-lb. blades are added to the discs, the rotor will weigh 180 tons and be 30 feet in diameter.



This compressor rotor and its blades will weigh 180 tons. It is used in a wind tunnel at Arnold Engineering Development Center.

Superpowered Radar

A powerful new radar height-finder being made for the U. S. Air Force is helping to strengthen defense networks of the United States and its allies.

General Electric engineers say the radar's energy, concentrated in a narrow beam like that of a searchlight, detects planes three times as far as previous units of this type. Exact range is classified.

(Interesting sidelight. The radio energy transmitted by the radar is so powerful that it can light fluorescent lamps over a hundred feet away, and can ignite flashbulbs tossed into the air immediately in front of the antenna.)

The radar height-finder is being used together with search radar to detect high-flying aircraft and to provide information on distance, altitude and flight direction.

The new radar is made in both mobile and fixed versions and has already been supplied in a large quantity for use in strengthening the radar fences guarding the North American continent, and for defense posts in countries receiving aid from the United States under the Mutual Defense Assistance Pact. Additional units are being produced for similar use.

In Arctic climates the radar is housed in a dome-shaped circular structure with a balloon-like radome made of woven glass fabric impregnated with a rubber compound. The radome is supported by air pressure, about a half pound per square inch, and can withstand winds up to 125 miles per hour. The radome protects the radar antenna from Arctic gales, snow and ice.

INTEROCEANIC CANAL

Colombia has announced plans to build a 350-mile waterway from the Caribbean Sea at Darien Gulf to the Pacific Ocean near Buenaventura. The $20-million waterway, using the Atrato and San Juan Rivers, is expected to be a shorter ocean-to-ocean route than the Panama Canal for Colombian coastal shipping.

SWITCH TO SOLUBLES

A growing trend toward soluble coffee in the U. S. is indicated by the significant increase in its consumption during the past ten years. From six per cent (on a cup-for-cup basis) of all coffee sold in 1945, soluble coffee has increased its share to an estimated 30 per cent in 1954.

WHAT ABOUT SHEETS?

The Army's "Honest John" artillery missiles are protected with electric blankets prior to firing. The blankets keep the missiles' explosive charge at proper temperature.

Electronics Research Engineer Irving Aine records radiation antenna patterns on Lockheed's Radar Range. Twenty-two foot plastic tower in background minimizes ground reflections, approximates free space Pattern integrator, high gain amplifier, square root amplifier and logarithmic amplifier shown in picture are of Lockheed design.

Jim Hong, Aerodynamics Division head, discusses results of high speed wind tunnel research on drag of straight and delta wing plan forms with Richard Heppe, Aerodynamics Department head (standing), and Aerodynamicist Ronald Richmond (seated right). In addition to its own tunnel, Lockheed is one of the principal shareholders in the Southern California Cooperative Wind Tunnel. It is now being modified for operation at supersonic Mach numbers.

Research Engineer Russell Lowe measures dynamic strain applied by Lockheed's 500,000 lb. Force Fatigue Machine on test specimen of integrally-stiffened Super Constellation skin. The Fatigue Machine gives Structures Department engineers a significant advantage in simulating effect of flight loads on a structure. Among other Lockheed structures facilities are the only shimmy tower in private industry and largest drop test tower in the nation.

C. H. Fish, design engineer assigned to Lockheed's Icing Research Tunnel, measures impingement limits of ice on C-130 wing section. The tunnel has a temperature range of −40°F. to +150°F. and maximum speed of more than 270 mph. It is the only icing research tunnel in private industry.

Advanced facilities speed Lockheed engineering progress

Lockheed's unmatched research and production facilities help make possible *diversified* activities in virtually all phases of aviation, military and commercial.

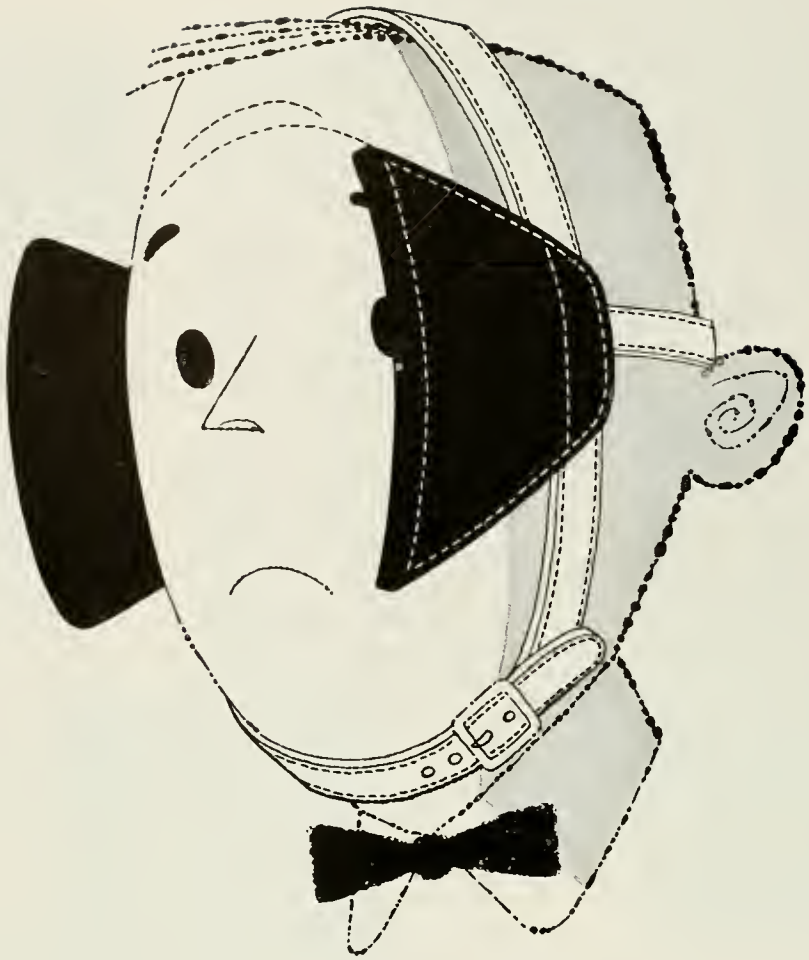
They enable engineers to test advanced ideas which would remain only a conversation topic in firms lacking Lockheed's facilities. They help give designers full rein to their imagination. They make better planes — and better careers.

Engineering students interested in more information on Lockheed's advanced facilities are invited to write E. W. Des Lauriers, Lockheed Student Information Service, Burbank, California.

Lockheed

AIRCRAFT CORPORATION

BURBANK **California**



We don't believe in "blinders" at Columbia-Southern

The management of Columbia-Southern knows that college men often do not know exactly what type of work will eventually interest them most. For that reason, new employees are not rigidly assigned to a specific duty.

Columbia-Southern believes that employees who are interested in their jobs do better work, and Columbia-Southern tries to fit every individual into the job in which he will be most satisfied and therefore most useful to the company.

The variety of possible assignments provides challenge for almost any technical graduate whether it be procurement and control of raw materials, plant design and construction, plant operation, traffic, purchasing, accounting, sales and technical service, research and development.

Columbia-Southern believes in looking ahead to broad horizons. It believes in giving its employees the opportunity to move ahead and to do constructive thinking. It does not believe in narrow, restricted vision. In short, it does not believe in "blinders."

Columbia-Southern is one of the fastest growing companies in the fast-growing chemical industry. Its progress is steady and solid. It is looking for men to grow with it.

If you'd like to be part of the progressive Columbia-Southern organization, write for further information. Address your letter to Department P at our Pittsburgh address or any of the plants.

COLUMBIA-SOUTHERN CHEMICAL CORPORATION
SUBSIDIARY OF PITTSBURGH PLATE GLASS COMPANY
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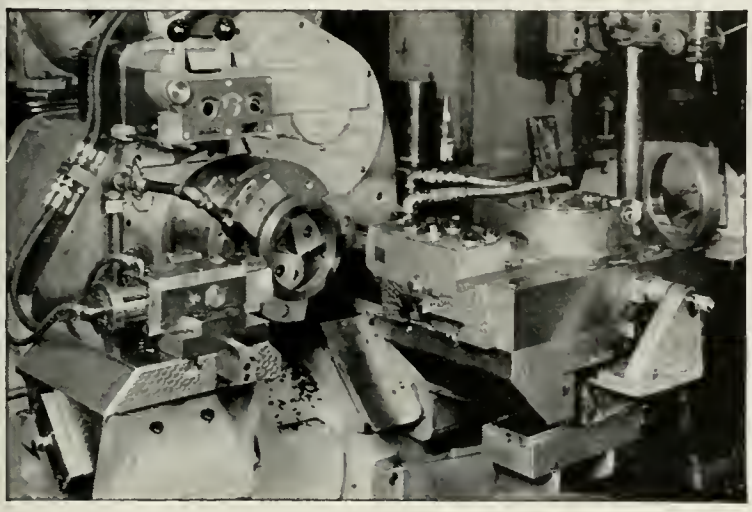
Another page for **YOUR BEARING NOTEBOOK**

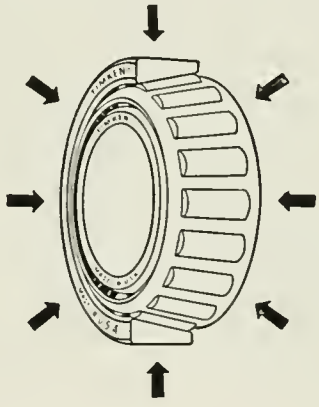


How to machine with high precision at high speeds

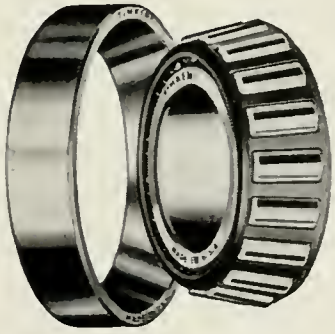
This lathe is designed to machine the races of bearings from 4″ to 8″ in diameter. And it must deliver high precision at speeds and feeds as fast as carbide tools can handle. To keep the spindle rigid under heavy combination loads, it's mounted on Timken® tapered roller bearings.

How TIMKEN® bearings maintain spindle rigidity

Because Timken bearings take radial and thrust loads in any combination, they hold spindles in rigid alignment, insure precision. And full line contact between the rollers and races of Timken bearings provides extra load-carrying capacity, prevents breakdowns.



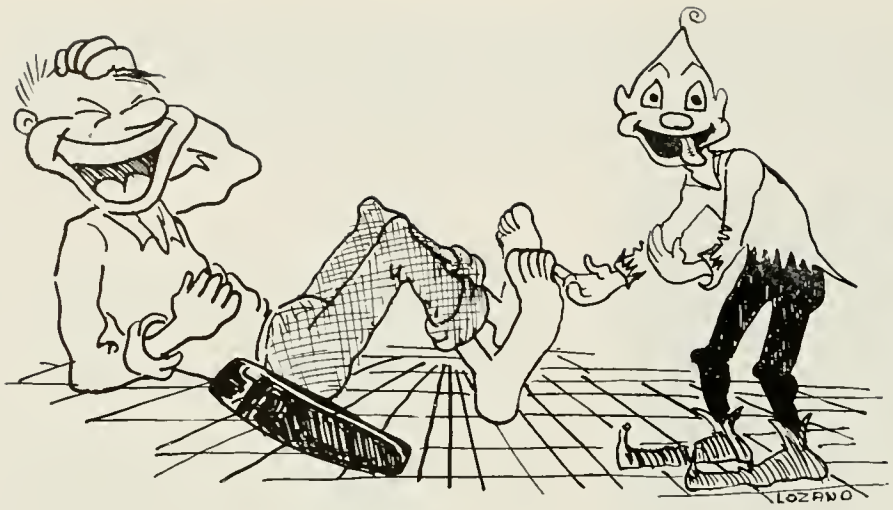
TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS



Want to learn more about bearings or job opportunities?

Many of the engineering problems you'll face after graduation will involve bearing applications. For help in learning more about bearings write for the 270-page General Information Manual on Timken bearings. And for information about the excellent job opportunities at the Timken Company, write for a copy of "This Is Timken". The Timken Roller Bearing Company, Canton 6, Ohio.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭
BEARING TAKES RADIAL ⓪ AND THRUST —⓪— LOADS OR ANY COMBINATION ✳



TECHNOCRACKS

Letters to the Editor Dept.
Dear Ed:

As Chief E.E. at State Pen I am supposed to sit in the electric chair to test it. If it doesn't work I lose my job. What should I do?

Frantic

* * *

She was only a janitor's daughter, but she knew how to turn on the heat.

* * *

There's something feminine about a tree. It does a strip tease in fall, goes with bare limbs all winter, gets a new outfit every spring, and lives off the sap all summer.

* * *

Sign in a local shop: "Our Lingerie is the Finest. Smart Women Wear Nothing Else."

* * *

On one occasion an unusually large crowd gathered to listen to the long list of candidates. As evening approached the crowd began drifting away until one man remained in the audience. The speaker waxed eloquent and when he finished, rushed down, shook his hand and thanked him for his support. "You don't have to thank me, friend, I'm the next speaker on this program."

* * *

A fellow was trying to start a conversation with the young lady who sat next to him at the table. "Do you like Kipling?" he asked.

The young lady giggled and then replied, "I don't know. How do you kipple?"

* * *

Composing a letter to the president of the firm, which he felt he so ably represented, the egotistical young salesman dictated to a stenographer:

"I fell that you should know, sir, that in order to obtain the above-mentioned contract, I found it necessary to employ every ounce of my personal charm and magnetism, my diplomacy and flawless tact. However, I am now pleased to report that my untiring efforts were crowned with success."

Gently the steno asked, "Crowtation marks on that last paragraph?"

* * *

A woman phoned her bank to arrange for the disposal of a thousand dollar bond.

"Is the bond for redemption or conversion?" a clerk inquired.

There was a long pause, then the woman asked: "Am I talking to the First National Bank or the First Baptist Church?"

* * *

The thing that keeps a lot of men broke isn't the wolf at the door, but the silver fox in the window.

* * *

"How far were you from the scene of the crime when the robbery occurred?" the lawyer asked the witness.

"Twenty-three feet and seven inches," the witness replied.

"How do you know so excatly?" the surprised lawyer inquired.

"Why, I thought some darn fool would ask me that question, so I measured it."

* * *

The 5th grade was having a geography lesson, and the teacher asked Bobby a question about the English Channel. "I wouldn't know about that one," the little boy shook his head doubtfully. "We only get one channel on our TV set."

* * *

If a lot of other people who haven't been worrying about things in general don't start pretty soon, we're going to quit, too.

At a dinner in Washington a noted man of letters was seated next to the young daughter of a naval officer. Her vocabulary was rather limited, but the turnover was amazing. "I'm awfully stucky on this guy Shakespeare," she confided. "I think he's tops. He's a wonder boy don't you think?"

"Yes," agreed the scholar solemnly. "I do think he's interesting; in fact, I think Shakespeare is just simply too cute for anything."

* * *

"Henry, dear," complained the little woman, "I've noticed lately that your kisses are getting colder."

"Nonsense, darling," rejoined the wily Henry. "You're simply been getting your cosmetics on a bit thicker."

* * *

The Negro woman stated she had four children, and the Florida census taker asked for their ages.

Violet: "Ah don't zackly remembah, but ah's got one lap chile, one floor creeper, one porch chile, and one yard youngun."

* * *

"STOP SINNER! Do you think that a glass of that vile brew will quench your thirst?"

* * *

Two drunks at Sweet Briar blundered into a girls' dorm coming home one night. One lost his head and ran; the other remained calm and collected.

* * *

And then there was the mechanical engineer who took his nose apart to see what made it run.

* * *

Little Boy—Teacher, may I leave the room?

Teacher—No, Henry, you stay right here and fill the ink wells.

* * *

She: My mother told me to say "No!" to everything you asked.

He: Really? Well, do you mind if I kiss you?

* * *

"May I take you home? I like to take experienced girls home."

"But I'm not experienced."

"No, and you're not home yet, either."

* * *

The quiet little freshman coed from the country was on her first college date, and thrilled beyond words. She didn't want to appear countryfied. She had put on her prettiest dress, got a sophisticated hair-do, and was all prepared to talk understandingly about music, art, or politics.

Her hero took her to a movie, and then to the favorite college cafe.

"Two beers," he told the waiter.

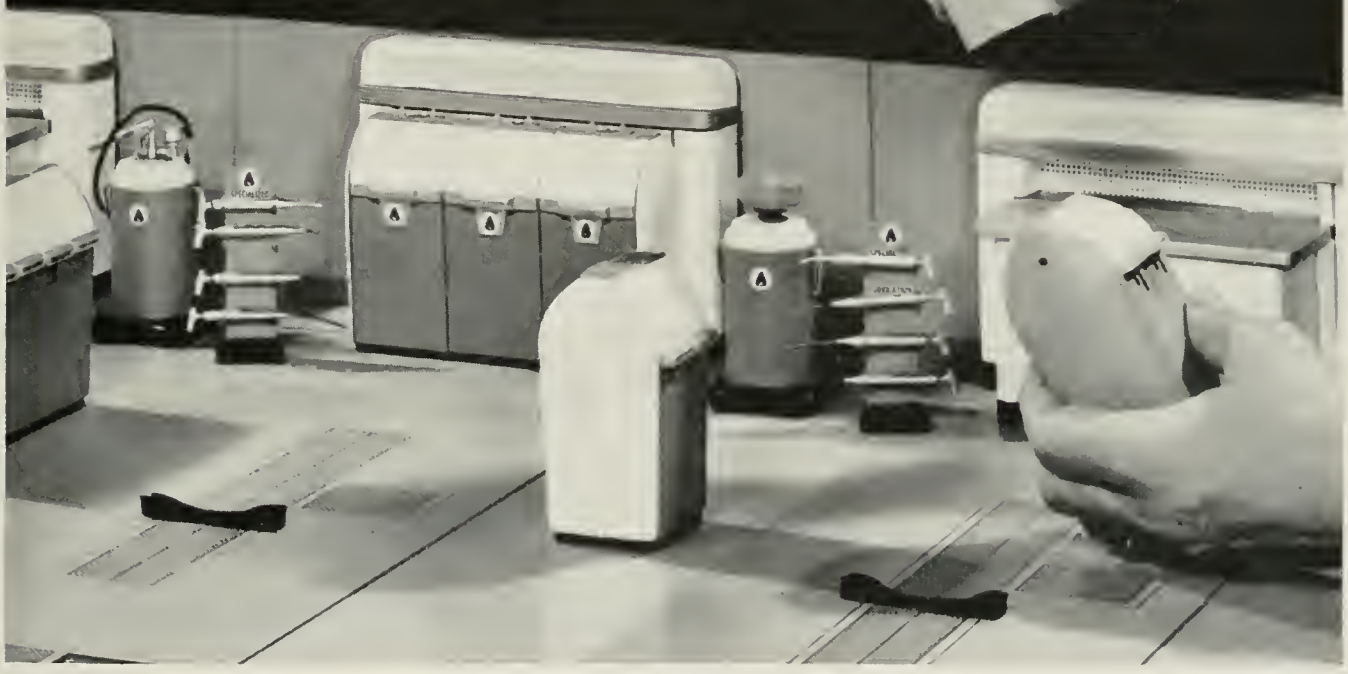
She, not to be outdone, murmured: "The same for me."

PHOTOGRAPHY AT WORK—No. 8 in a Kodak Series

Kodak
TRADE-MARK

Photography shows prospects

how their new service stations are going to look and operate



Alemite sets up scale models of their service station equipment on the customer's own floor plan—photographs them—and portrays the new custom-built station ready for action

SALESMEN don't just pull lube racks, grease pumps and other service station equipment out of a sample case. They're far too big—far too bulky. Besides, final location and arrangement count heavily in how well they are going to work out.

The Alemite Division of Stewart-Warner solves the problem with photography. Prospects see new service station equipment virtually right in their own premises.

It works this way. The salesman sends in a rough sketch of the space available, with windows and columns marked. Experts fit exact replicas of racks, lifts, and other equipment to the plan, then put the camera to work. The customer pictures his new station—modern, efficient, handsome—and the sale is well on its way. It's an idea for any company with bulky products to sell. Photography is a great salesman for any business, large or small. And it's very much more. It works in all kinds of ways to save time, cut costs, reduce error and improve production.

Graduates in the physical sciences and in engineering find photography an increasingly valuable tool in their new occupations. Its expanding use has also created many challenging opportunities at Kodak, especially in the development of large-scale chemical processes and the design of complex precision mechanical-electronic equipment. Whether you are a recent graduate or a qualified returning service man, if you are interested in these opportunities, write to Business & Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N.Y.

Eastman Kodak Company, Rochester 4, N.Y.

JOHN B. NOLTE. Purdue University '54, asks:

"What is G.E.'s Manufacturing Training Program?"

The Manufacturing Training Program at General Electric is a program of basic training for manufacturing leadership, including planned rotational work assignments and related classroom study for outstanding young men who are interested in a career in manufacturing. It was organized to meet the increased demand for effective manufacturing leadership and technical "know how," in line with the expansion and development of the Company's operations by developing trained men to fill future key positions in the organization.

Who is eligible for this program?

In general, the Program is open to college graduates with degrees in engineering and science, and a limited number of business administration and liberal arts graduates. We are looking for outstanding young men with sound educational backgrounds, well-balanced personalities, demonstrated thinking abilities, and having the potential to develop toward top level responsibility in key assignments.

How long is the program?

The normal length of the Program is three years. Assignments are normally 6 months in duration and provide experience opportunities in diversified manufacturing operations. Geographical moves occur at annual intervals.

What type of work assignments are made?

Work assignments are provided in all phases of manufacturing and related functions so that each man will acquire knowledge of manufacturing engineering, including manufacturing methods and techniques, shop operation, production control, personnel administration, labor relations, engineering activities, sales and manufacturing co-ordination, and general business administration.

In addition to job assignments, related study courses cover such subjects as Company organization, manufacturing operations, labor and personnel relations, business administration, law and relationships between manufacturing and other functions of the business. Progress on the job and in classroom work is carefully observed and reviewed periodically with each man to assist him in his career.

What happens after training is completed?

After completing the training program, graduates are placed in operating departments and divisions throughout the Company in positions where leadership and initiative are needed. All placements are made in relation to the aptitudes, abilities, and interests of the graduates.

At General Electric, manufacturing operations involve the administration and supervision of activities of more than 100,000 men and women in more than 100 plants, who are involved in the making of some 200,000 different products.

The wide scope of these activities, the great variety of products, and the diversity of manufacturing activities offer limitless opportunities and exciting challenges to college graduates today.

Manufacturing training is a foundation for leadership—and an opportunity to build a satisfying, rewarding career in one of America's most important industries.

If you are a graduate engineer, or a graduate with definite technical inclinations that include an interest in the career possibilities in manufacturing, see your college placement director for the date of the next visit of the General Electric representative on your campus. Meanwhile, for further information on opportunities with General Electric write to Manufacturing Training Services Section, Bldg. 36, General Electric Company, Schenectady 5, New York.

You can put your confidence in—

GENERAL ELECTRIC

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Urbana, Ill.

Chemistry Library
Noyes Laboratory
Urbana, Ill.

ILLINOIS TECHNOGRAPH

PREVIEW OF YOUR ENGINEERING FUTURE

FLUORIDATION . . .

GERMANY'S GREATEST ACE . . .

MARCH, 1955 **.25**

Robert L. Land, Jr., Class of '51,
speaks from experience when he says,

U.S. Steel offers thorough training . . . exposes the graduate engineer to many interesting phases of the steel industry

ROBERT L. LAND, JR., graduated with a B.S. in Chemical Engineering in February 1951. He had previously been interviewed by U.S. Steel college recruitment representatives and had been offered a job. He began working in the Coke Plant at the Gary, Indiana Works of U.S. Steel immediately after graduation.

After extensive training and several promotions, Bob was made General Heater Foreman on November 1, 1954. This exceedingly important job makes him responsible for the proper heating and the quality of *all* coke produced at the Gary Works—the second largest coke plant in the world—with 16 batteries of coke ovens producing 15,000 tons daily. He has a crew of 60 and 8 foremen working under him.

Bob feels that U.S. Steel really gets the young graduate engineer off to a good start with a well-planned and complete training program. He says, "U.S. Steel offers the graduate engineer an excellent chance to work in a number of different fields."

This enables the graduate who has not decided on his exact field to look around the big steel industry from within and to find the type of work that suits him best. After a man is given the chance to really find himself and has been adequately trained, "U.S. Steel offers security and an unlimited possibility of advancement providing the engineer shows initiative and the willingness to work."

If you are interested in a challenging and rewarding career with United States Steel and feel that you can qualify, you can obtain further information from your college placement director. Or we will gladly send you our informative booklet, "Paths of Opportunity," upon request. Just write to United States Steel Corporation, Personnel Division, Room 1622, 525 William Penn Place, Pittsburgh 30, Pa.

SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

USS

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CATERPILLAR MACHINES POWER THE WORLD'S GREAT ENGINEERING JOBS

The young engineer who works for Caterpillar Tractor Co. has a part in great achievements. All over the world new construction is going forward at an unprecedented pace. And the powerful diesel engines and earthmoving machines built by Caterpillar are leading the way.

This is a dynamic industry—an industry of growth. In the next few years engineering strides made by Caterpillar will surpass all that have gone before. To share in this advance the company needs young men of vision, trained as Mechanical, Metallurgical, Agricultural, Electrical, Civil Engineers and others. They will do challenging work in research and development, design, manufacturing, sales and many other fields. They will have the best in laboratory facilities and interesting assignments in Caterpillar plants as well as in the field.

Such men can expect permanency and promotion. Starting pay is good. In addition, executive positions at Caterpillar are filled from within the organization.

It's time now to start thinking about a Caterpillar job. Representatives of the company will be on campus for interviews. Consult your placement office. Meanwhile, if you would like further information, write to W. C. van Dyck, Employee Relations General Office, Caterpillar Tractor Co., Box 1L-1, Peoria, Illinois.

CATERPILLAR

REG U S PAT OFF

DIESEL ENGINES • TRACTORS • MOTOR GRADERS • EARTHMOVING EQUIPMENT

NEW MISSILE SYSTEMS RESEARCH LABORATORY RISES AT LOCKHEED

Scheduled for occupation this fall, Lockheed's new Missile Systems Research Laboratory is now well along in construction. First step in a $10,000,000 research laboratory program, it is especially designed to provide the most modern facilities for meeting the complex problems of missile systems research and development.

Scientists and engineers able to contribute importantly to the technology of guided missiles are invited to write.

Dr. E. H. Krause, Research Laboratory head (left), examines blueprints of the new laboratory with E. R. Quesada, Missile Systems Division vice president and general manager (center), and W. M. Hawkins, chief engineer, during ground-breaking ceremonies.

Lockheed MISSILE SYSTEMS DIVISION

research and engineering staff

LOCKHEED AIRCRAFT CORPORATION • VAN NUYS • CALIFORNIA

A MESSAGE TO
COLLEGE ENGINEERING
STUDENTS

from Donald C. Burnham, Vice-President
Manufacturing,
Westinghouse Electric Corporation
Purdue University, 1936

To the young engineer with a creative mind

America is on the threshold of the *automation era.*

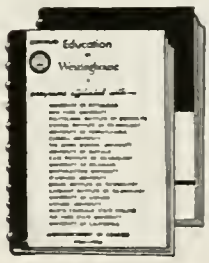
New automatic machines with their electronic brains are opening the way to a tremendous industrial development in which machines will largely replace man's routine brainwork and handwork.

Westinghouse is taking a leading part in developing equipment for the automatic factory. At our new Columbus, Ohio plant, refrigerators move along *27 miles* of automatic conveyors, with many parts being installed by automatic assembling machines...refrigerator controls are automatically calibrated... automatic testing devices maintain quality control...and the crated refrigerator is automatically conveyed to warehouse storage.

At Westinghouse, young engineers like you are playing an increasingly important role in such new developments for all kinds of industry. Here, there is plenty of room for your creative talents to expand—in designing new products . . . and in developing new improvements for existing products. It's a fascinating job that offers you real opportunities for growth.

And at Westinghouse, we recognize *individual ambition* as well as technical ability. There will *always be a place* for the young engineer who wants to forge ahead. For professional development you can do graduate work toward Master's and Ph.D. degrees in 19 universities. You will be treated as an individual and Westinghouse will do all in its power to help you reach your goal.

G-10282



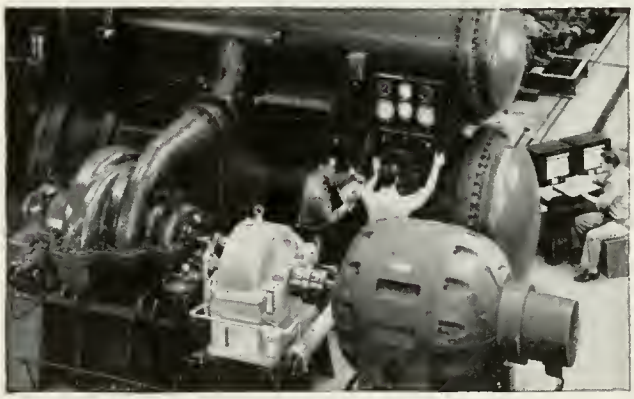
Ask your Placement Officer about career opportunities at Westinghouse, or write for these two booklets: *Continued Education in Westinghouse* (describing our Graduate Study Program) and *Finding Your Place in Industry.*

To get these booklets, write: Mr. C. W. Mills, Regional Educational Co-ordinator, Westinghouse Electric Corporation, Merchandise Mart Plaza, Chicago 54, Ill.

YOU CAN BE SURE... IF IT'S
Westinghouse

"POWER OFF!" Test operations are directed from this central control room, where special measuring instruments greatly speed up the collection of pump performance data. That's one way Worthington products are made more reliable by using . . .

. . . the world's most versatile hydraulic proving ground



COMPREHENSIVE TESTS are run on a Worthington centrifugal refrigeration unit (lower left) now in service as one of the Arabian American Oil Company's central air conditioning units in Dhahran, Saudi Arabia.

When you make pumping equipment that has to stand up and deliver year after year anywhere in the world, you've got to be sure it will perform as specified.

That's why we built one of the world's largest hydraulic test stands at our plant in Harrison, New Jersey. Here, over a half-acre "lake," we can check the performance of anything from a fractional horsepower unit to pumps handling over 100,000 gallons a minute. When you realize there are thousands of sizes and types of centrifugal pumps alone, you get an idea of the versatility we had to build into our proving-ground.

Naturally, our new test equipment is a big help to our research engineers, as well as our customers. Now they get performance data on products quickly and accurately. Using it, we can save months, even years, in developing new Worthington fluid and air-handling devices — equipment for which this company has been famous for over a century. For the complete story of how you can fit into the Worthington picture, write F. F. Thompson, Mgr., Personnel & Training, Worthington Corporation, Harrison, N. J.

4.25A

See the Worthington representative when he visits your campus

See the Worthington Corporation exhibit in New York City. A lively, informative display of product developments for industry, business and the home. Pork Avenue and 40th Street.

WORTHINGTON

When you're thinking of a good job—think high—think Worthington

AIR CONDITIONING AND REFRIGERATION • COMPRESSORS • CONSTRUCTION EQUIPMENT • ENGINES • DEAERATORS • INDUSTRIAL MIXERS
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It's Never a Waste . . .

Soon you will be faced with the problem of what elective to take. While preregistering, don't be afraid to take that step across Green street.

While it is the traditional sport to poke fun at the commerce students, it is wise to take some commerce courses. Even though salaries are good for engineers, they may be increased tremendously by getting into management work with your engineering background. Advancements in this classification are not limited, while a straight engineer must stop at chief engineer. An engineer has a big advantage when going into production control work. He has complete knowledge of the processes to be done as well as the management side of the work. An increasing number of companies are getting presidents with engineering background. Don't wait and say "I could have been the president of the company had I gone into management with my engineering background."

Marketing is another good field that will help an engineer. As an engineer, you will know something of the kind of consumer your product must satisfy. You must know his tastes, quantitative needs and budget. Only then can you best satisfy your customer.

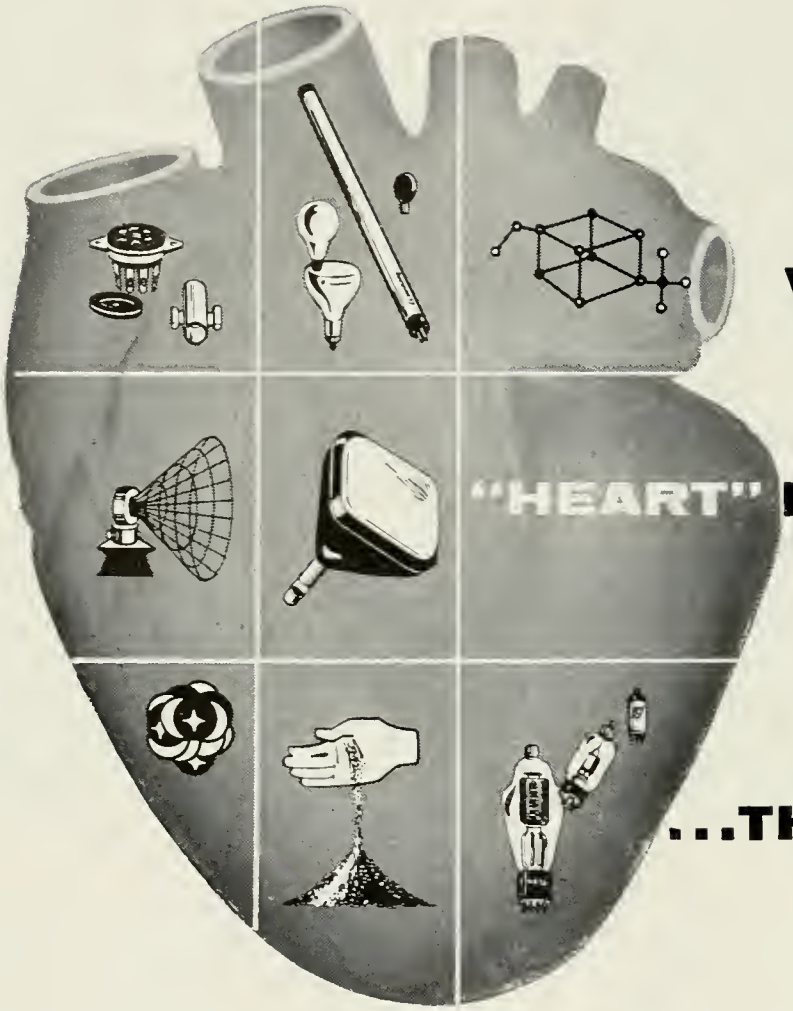
Have you ever considered working in a foreign country? You could take a foreign language while in school. While the foreign language is not always a requirement, it is always helpful, and sometimes raises your pay.

Speech and rhetoric courses (I know I said a dirty word, but I must) give you confidence in expressing yourself. It is a fact that for each engineering problem, the answer is accompanied by a complete written report. If you don't like rhetoric courses, there is another solution. The TECHNOGRAPH offers excellent opportunities in technical writing.

Psychology, history, and literature courses are far from waste if you expect to take part in conversation with anyone. Employers, consciously or otherwise, look for an employee that is well versed in happenings and has a good vocabulary.

Take an intelligent look at courses offered as non-technical electives and get something out of the work you put into them.

D. F. K.



WHAT SYLVANIA'S "HEART" BUSINESS MEANS TO YOU ...THE ENGINEER

Supplying vital components and parts that are the "heart" of hundreds of industrial and consumer products of other manufacturers...that's Sylvania's "heart" business.

It's an *extra* stability factor that safeguards your long-range career plans!

When you combine this fact with the company's leading position as a manufacturer of such Sylvania consumer products as: television sets, radios, fluorescent, incandescent and photoflash lamps, you can readily see that Sylvania is a company with exceptional diversity. That's why Sylvania can offer you the security you need for professional success.

In the brief 53 years since its founding, Sylvania's dedication to young, aggressive management (the average top executive age is only 45), has meant expansion into an organization of 45 plants, 12 laboratories in 11 states, with over 24,000 employees.

To keep pace with the demand for Sylvania's products, our engineering staff has more than doubled in the past 6 years. 1954 saw the addition of 2 new laboratories, the completion of a new television manufacturing plant, a TV picture tube plant, and the start of a new incandescent lamp plant.

Diversity . . . stability . . . growth — these are the foundations that make Sylvania an excellent place to build your career in engineering.

For detailed information on Sylvania's program for graduating engineers, see your College Placement Office. Or send for our comprehensive booklet, "Today and Tomorrow With Sylvania" by writing to Supervisor of Technical Employment.

SYLVANIA

Sylvania Electric Products Inc. 1740 Broadway, New York 19, N. Y.

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THE ILLINOIS TECHNOGRAPH

volume 70 number 6

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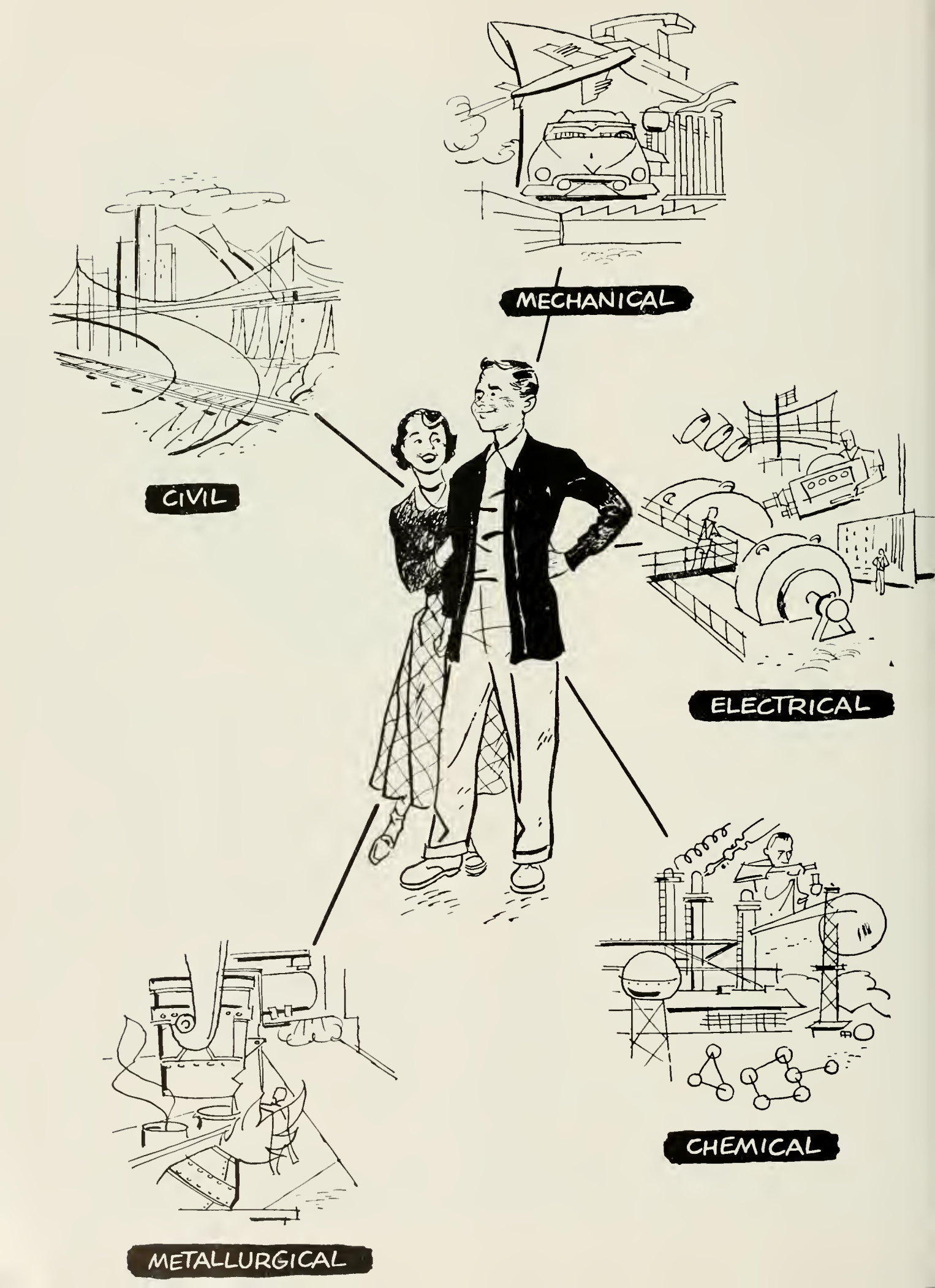
our cover

A preview of your engineering future would envision the design and supervision of construction of numerous structures, machines and devices, some yet unheard of. Engineering as a science has utilized the forces and material of nature and has applied them to the needs of man. (Cover courtesy of Kaiser Aluminum and Chemical Sales)

our frontispiece

In each of these phases of engineering there lies vast fields of unexplored phenomenon. Any of which should present a challenge to you. While the ultimate choice of fields is up to you, it may be helpful to talk over the problem with your advisor. (Drawing courtesy General Motors Corp.)


MECHANICAL
CIVIL
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The Engineering Open House

by Keith A. Yarborough, San. E. '55

Perhaps it is a bit hackneyed to start an article with a question—but to ask "What is the Engineering Open House?" is to ask many questions. Since 1920 the doors of the Engineering Campus at the University of Illinois have been thrown open to visitors from all over the state. People from industry, observers from other universities, high school students and teachers, and hosts of others who perhaps have no direct relationship with engineering but just like to learn "what makes the wheels go 'round" have attended these exhibitions. Yet to say that the Open House is simply an exhibition is to do a great injustice to those faculty and students whose year-round efforts have made the event so successful. A glance at the record shows that it is much more than an exhibition.

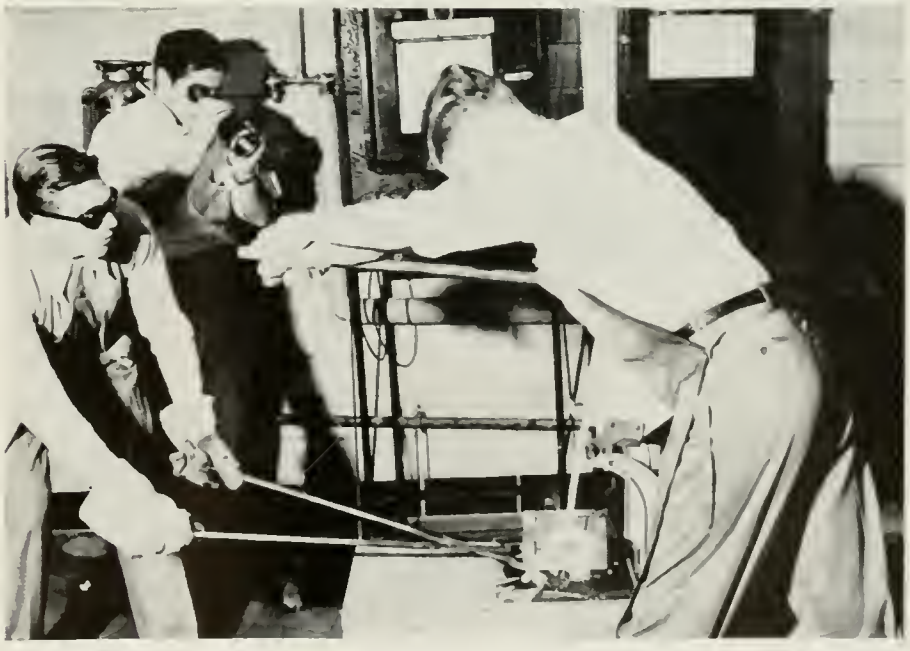
The Open House is the result of some 45 years of evolution. Beginning in the early years of the century, it became the policy of various departments to sponsor "shows" and "open houses" at which times the students and faculty collaborated in demonstrations and lectures. Thus, in 1906 when the Department of Physics held its first annual Open House, the precedent and inspiration for the present-day Engineering Open House was established. This 1906 showing of departmental equipment was held in the laboratories of Engineering Hall, where Physics was then located. The exhibits consisted of displays of apparatus in the fields of light, sound, wireless telegraphy, and other electrical operations, accompanied by lectures on the principles involved. These basic physical concepts have been enlarged upon so that demonstrations of many principles appear today which were relatively unknown in 1906, including those on modern electronics as well as atomic and nuclear physics.

The next spring, in 1907, the Department of Electrical Engineering organized the Electrical Engineering Show. The purpose was to raise funds in order to contribute to the construction of a memorial in honor of steamboat builder Robert Fulton which was to be erected in New York City. The show was a modest affair which required only a week's preparation at virtually no expense and for which a small admission fee was charged. The results took the originators by surprise, as the 1600 who attended enabled $250 to be donated to the memorial fund.

Encouraged by this success, the originators held subsequent shows, each a little more elaborate than the preceding. The proceeds were at first used to improve the furnishings of the Electrical Engineering Society reading room in the E. E. Laboratory. By 1913 the attendance had grown to about 3600, a capacity crowd which taxed the facilities of that lab to its limit.

In 1915 an important precedent of dual significance was established by the use of commercial exhibits donated by outside companies as a distinct feature of the Show. Because this addition required much additional space for equipment, the show was extended over three days and several buildings were used besides the E. E. Lab. Subsequent shows up to 1922 followed this same plan. By this time the show had become so enlarged that 450 student workers and demonstrators operating on a $4,000 budget were required. The show continued to be successful and to return a profit, which was being used to aid the Technograph and other University interests.

In 1924 such national recognition had been gained that commercial organizations and utility companies were eager to exhibit their products. Thus, the



M.E. students are pouring hot metal for sand castings. Samples are given away at the Open House with the demonstrations.

Shows from 1924 until the war necessitated termination of the event in 1942 were able to present many unusual and spectacular demonstrations. Among these, some worthy of note were automatic dial telephone systems, model hydroelectric plants and power transmission lines, radio broadcasting and receiving equipment, television, talking movies, and a list of others too long to enumerate. The proceeds of these Shows were placed in an E. E. student loan fund which is still in existence.

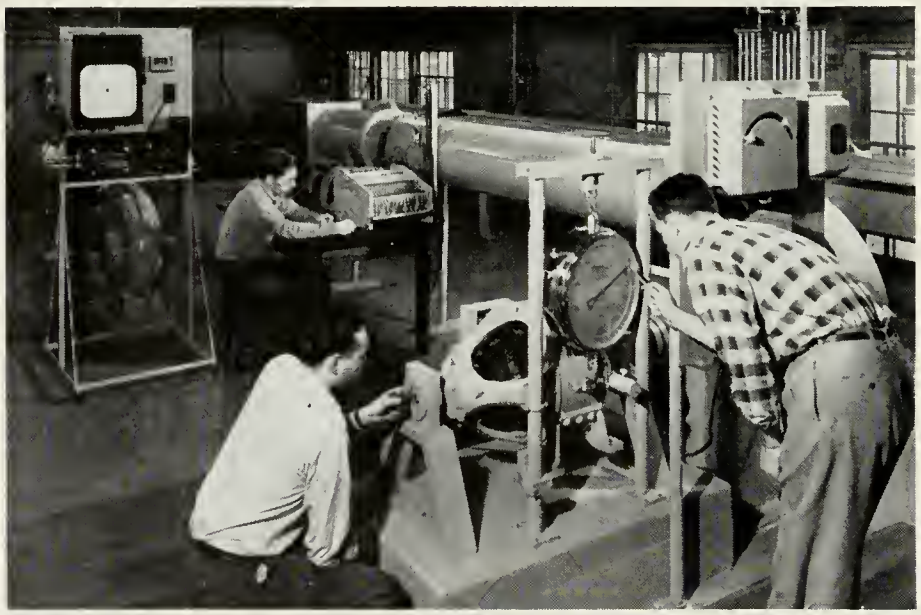
Also worthy of mention is the interest which the Shows had created among the people of the entire state. Started on a campus-wide scale, by 1936 and 1938 they were attracting crowds that ranged from 4000 to 6000 people, who came to the Show in everything from private cars and school or chartered buses to trucks. A large percentage of the guests were high school students and teachers, a fact which enabled the Show's directors to obtain reduced rates on the Illinois Central and Big Four railroads in 1936. Such groups were also assigned student guides who conducted them on tours of the University's campus before taking them through the Show.

In the later years, from 1938 to 1942, the tendency was to demonstrate more of the University's equipment and student work and thus to diminish the commercial flavor. In so doing, students devised many interesting exhibits. Most had a serious purpose, seeking to illustrate some of the latest advances in electrical engineering (though a few were purely for a showmanship purpose).

In the fall of 1914, a few years after the first E. E. Show, members of the Student Branch of the American Society of Mechanical Engineers acted as hosts at the first annual Mechanical Engineering Open House. Some 2000 people representing all departments of the University passed through the displays of student work and demonstrations of machines in operation, and heard talks on subjects concerning the popular mechanics of the day.

Exhibitions held in the following years proved to be even more successful. The attendance reached nearly 5000 persons by the fourth and last M. E. Open House, held in the spring of 1919. During these events, the practice of distributing ashtrays, paper weights and other small mementos as well as the showing of movies had been adopted. Last year nearly 20,000 people viewed displays demonstrating subjects ranging from arc welding to fluid flow studies. Here again, the fundamental engineering principles have been expanded, and reapplied by some 35 graduating mechanical engineering classes, to give spectators a view of the latest model automobile and punch press.

Inspired by the success which these several shows had enjoyed, the first regular all-engineering Open House was held in the spring of 1920, commemorating the centenary of the birth of James Watt. The Physics and M. E. Open Houses were discontinued at this time to give greater chance for success to the all-college venture. The public was invited to inspect the facilities of the Engineering College and to see the displays which had been set up in the laboratories, drafting rooms, and shops. The first Open House Program appeared at this time in the form of a 20-page pamphlet. It briefly described sixty-odd exhibits and contained a map of the engineering campus with a suggested itinerary. This general form has been maintained and is essentially the same layout used today.



Horsepower tests are made in the internal combustion laboratory. Dodge V-8, Chevrolet, G. M. C., and other engines are tested for horsepower output, fuel economy and other things.

Other Open Houses, later called Illinois Student Engineering Exhibitions, were held throughout the years. Students in all departments participated and were guided in their efforts by the Engineering Council. In 1928, the Open House was so scheduled as not to conflict (in year) with the E. E. Shows. Also, the policy was adopted of inviting groups from the high schools of the state, interested persons from out-of-state or other nearby colleges, and other such groups.

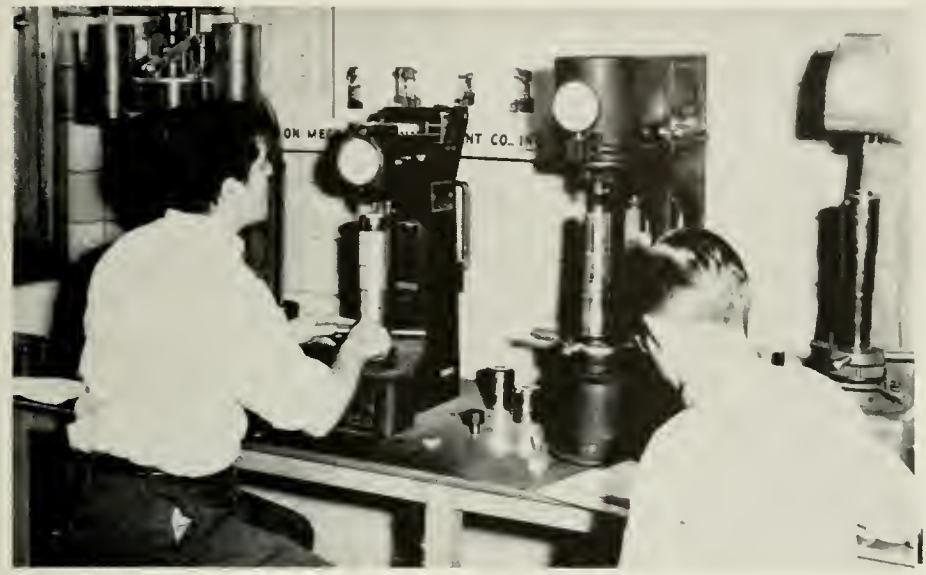
As was true of the E. E. Show, the all-engineering show was dicontinued during the war years. During the immediate post-war period the E. E. Show was reorganized and became a definite part of the newly named Engineering Open House. Starting in 1948 and carrying through 1952, the Open House was held biennially. However, following the 1950 show, it was suggested that the Open House be planned as an annual affair. This proposal was accepted by both the Engineering Council and the Executive Committee of the College of Engineering as an experiment in 1952 and 1953. Hence, the 1955 Open House represents the fourth time that the annual event has been successfully planned. It is therefore well beyond the experimental stage.

Since its beginning in the departmental exhibition, the Engineering Open House has never been planned or executed as a "stunt show" (though some of its exhibits are indeed quite amazing and spectacular). One major purpose has always been to give benefit to the students participating, and it is therefore primarily educational. The long standing goal has been to better acquaint the students and faculty of the College of Engineering and of the other colleges on the campus, as well as the public in general, with the facilities and work of the college. The exhibits are intended to readily demonstrate to the public some of the fundamental principles upon which the science of engineering is based and to point out how the student is equipped to utilize these principles during and after his course of study.

Following the lead of the E. E. Show, outside exhibits such as those from commercial organizations are sought only when they demonstrate the desired concepts more clearly than can student-prepared displays. Never has admission been charged to finance any of the Open House exhibitions.

During the discussion of the evolution of the Engineering Open House,

reference was made to the progress in the science of engineering which can be traced by the student exhibits held over the years. This is another important objective which the Open House seeks to realize. Thus, the Engineering Open House is valuable as a means of aiding progress. The exhibits and demonstrations each year attract people from three general groups. The largest group consists of those who have a general interest as citizens of the State. The second group consists of those who are interested in the Engineering College as a center of research and training for future engineers—i.e., industry. The third group is composed mainly of high school students who have scientific interests and wish to learn whether engineering should become their life's work. The Open House attempts to answer the questions of these groups by annually placing the entire facilities of the College on display.



Rockwell hardness testers meosure the hardness of materials without damaging it. The test leaves a small indentation in the specimen.

To the general observer this is impressive and imparts the feeling that he, as a citizen and taxpayer of the State, has had a hand in making this center of technical education and reserch possible. The industrial person sees students, the engineers of the future, organizing and conducting a large-scale enterprise. He observes that the men involved have had to take into consideration practically all of the factors involved in any industrial and engineering project. Realization of these factors requires organizational abilities and gives the students many opportunities to test their judgment and ingenuity.

First of all, the proper setup of student officers who will be in charge must be established. This selection of student leaders requires careful consideration as to the kinds of ability needed in each office that is to be filled, as well as an analysis of the abilities of the men who are eligible to fill these offices. Such a project also requires that thought be given to financial and business matters and to the problems of setting up the proper machinery for operation. In addition the exhibits must be selected on the basis of their educational value and public appeal. Advertising and publicity, in the form of printed programs, radio and TV shows, automobile stickers, newspaper articles, speeches and posters, must be carried out. Thus the Open House is an undertaking requiring the time and efforts of many students working together toward a common goal.

All of these things are readily observable to those who care to look "behind the scenes." Here another great educational value is again observed—the fact that some men discover and perfect abilities of leadership which will serve them well in later work whereas others, though lacking in leadership perhaps, find that they are qualified to handle practical problems as these are encountered. Perhaps most important is the invaluable experience which teamwork provides and the sense of comradeship which it instills in all.

Thus the third interested viewer, the high school student, soon realizes that this is indeed a student enterprise. In the various exhibits he not only sees *what* the practicing engineer does in any particular field but he is made aware of *how* the student engineer is trained to think and act in such situations. Proof of the value of such training is furnished by the show itself. Indeed, no one man could conceive of and execute the many duties and tasks required for a successful Open House; but a group of men, using what they have learned to attack new problems, can achieve this goal. This is that part of the engineering education which is learned not so much in the classroom as outside it in the meeting rooms and around the conference tables.

And what about this? Indeed, answering this "what" will aid in telling what the Open House is. The students and faculty have plans for this year which are designed to demonstrate to everyone the potential for teaching and research that the College of Engineering of the University of Illinois possesses. The exhibits will be so arranged and talks on them so presented as to best point out what the engineering student is taught in his study program and how this training is directly applicable to the problems encountered "in the field." In so doing the exhibits themselves will be selected and utilized in such ways as to demonstrate the fact that they are not primarily teaching devices upon which examination questions are based but are functional units designed, built, and applied to satisfy specific needs and fulfill definite purposes. Every attempt will be made to answer questions not only on *how* they work but also *why*. Also, this year, particular emphasis is being placed on the values of the engineering profession in modern society and how young men are prepared to meet the challenging problems of the science by study here at the University.

As to the actual exhibits—they are too numerous to name (requiring some 20 pages of Program each year to describe). While some groups are running miniature ram-jet engines, others will be distilling alcohol and still others will be breaking concrete cylinders. One organization even hopes to furnish thirsty visitors with glasses of purified Boneyard water. Yet all these displays will be showing the same thing, basically; that the fundamental principles of engineering are being applied daily in solving the problems which enable us to be a *progressive* society.

We've talked a good deal about the Open House—its history, its purposes and its achievements. It should be apparent that the "what" of the Engineering Open House is not easily answered, for the real answer lies in the work which the participating students carry on. The success of the venture lies with them and challenges their ingenuity and "stick-to-it-iveness." What is considered and applied here is no different from the planning and execution of any engineering undertaking. Thus, when all the problems have been surmounted and the visitors arrive on March 11, 1955, the Engineering Open House again serves as a symbol of the promise and attainment of the engineering profession.

SANITARY ENGINEERING

by Frank L. Flood

It will be the purpose of this paper to concentrate on what the young sanitary engineer should learn through college training and during the first few years thereafter.

First, I would like to summarize certain general beliefs with which I am in accord.

1. The sanitary engineer must be thoroughly grounded in the fundamental principles of the natural sciences: mathematics, physics, chemistry, geology, and biology.

2. The arrangement of courses in these subjects should be in accordance with the scope of the problems which generally arise in the practice of sanitary engineering.

3. The elements of mechanics, structural design, materials of construction, hydraulics, design of waterworks and sewage works, principles of public health and sanitation and elements of electrical and mechanical engineering should be among the subjects studied.

4. The young engineer should be able to handle surveying instruments with reasonable skill, keep notes in the field, and plot the work in the office.

5. He should be able to draw reasonably well and needs to have an appreciation of the value of well-made plans and the value of clear graphical presentation of the facts by the use of plans, charts, and diagrams. The technical graduate should realize that drafting is not too menial a task for him to perform.

6. He should be able to perform the routine sanitary analyses of water and sewage.

7. The sanitary engineer needs to have a reasonably broad cultural background and to this end subjects such as English, history, and literature should be included in his education.

8. Some degree of training in the principles of economics and in business and public health law should be acquired.

9. A young engineer should learn the need for economy in the engineering expense put into the study and solution of a problem. He should have judgment as to the reasonable amount of time needed to perform a task.

10. The technical training should give a man sufficient instruction in report writing to enable him to recognize the facts to be set forth and their relative importance and should train him to present facts clearly and in logical arrangement.

11. The young engineer should become informed of the ordinary political practices and the normal operations of municipal, state and federal agencies, particularly as they affect public sanitary engineering works. Service in an appointive or elective capacity, particularly in municipal government, is of considerable value in learning to deal with municipal authorities in public works matters.

For the most part, the above conclusions relate to education up to the stage of postgraduate work. Some elaboration as to the training of the graduate engineer may be of value. While sanitary engineering covers a broad field of engineering relating to the betterment and control of environmental factors affecting the public health, the more specific work of the sanitary engineer in a private engineering organization offers sufficient scope for this discussion.

The engineering work of an organization such as the one of which I am a partner has to do primarily with investigations and reports, plans and specifications, supervision of construction, and operation of waterworks, sewage works, industrial waste disposal, drainage, garbage, and refuse disposal. Each individual project is administered by a partner with a project engineer in responsible charge. Usually the project engineer is a professional sanitary engineer.

For investigations and reports, the field work may involve surveys, gaging, sampling, testing, and design and operation of pilot plants. The field men may include rodmen, transitmen, party chiefs, assistant engineers and chemists. The reports are compiled by the project engineer with the help of assistant engineers. The young sanitary engineer should be capable of handling the job of party chief, assistant engineer, or chemist, the latter operating under the supervision of a chief chemist.

The preparations of plans and specifications on a project proceed under the direction of the project engineer. Functional drawings are made by the engineers and assistant engineers who are normally young sanitary engineers. Most modern sanitary engineering works are so complex that the design then proceeds through office departments which include structural, architectural, mechanical, and electrical. Each department is headed by a senior engineer or architect and includes the designers, detailers, draftsmen, and tracers. No one in these categories needs to be a sanitary engineer, but drafting ability will be helpful to a young sanitary engineer both in securing a job and to retain steady employment.

A detailed quantity estimate is usually required as a basis for estimates of cost and the young sanitary engineer can be useful and at the same time learn much about the functional details of the design while on such work.

Specifications and contract documents are normally prepared by the specifications engineer assisted by the senior engineers and project engineers. The young sanitary engineer must learn requirements for preparation of specifications and contract documents and usually learns by assisting either the project or the specifications engineer.

In the construction of a project, the professional sanitary engineer may furnish field parties to supply lines and grades, inspectors and resident engineers. It is very worthwhile for a graduate sanitary engineer to spend some time in the field as an inspector or resident engineer.

Frequently, the professional sanitary engineer has the responsibility for operation of a sewage treatment plant or water purification plant during the first year or two of operation. The young graduate sanitary engineer would be very forunate to secure the experience of operating either type of plant under the supervision of the professional engineer.

A combination of experience during the early years following the graduation of a sanitary engineer from college which includes investigations and reports, preparation of functional drawings, detailed estimates of cost, preparation of specifications and contract documents, inspection of construction and operation of plants should be ideal background toward the ultimate development of a professional sanitary engineer.

Continued employment and advancement of the young sanitary engineer de-

pend upon character, ability, and opportunity.

The sanitary engineering profession is still rapidly growing and developing. At no time are there complete up-to-date textbooks. In order to be properly informed, it is essential to a sanitary engineer to read the technical literature in his field, attend society meetings, study the data furnished by manufacturers, and inspect works that have been built.

Bound volumes of magazines are available in most large engineering offices and in other engineering libraries maintained by the universities and societies. However, the writer has found it extremely valuable to maintain a reference file of material relating to the particular field in which he is engaged, to clip most of his personal technical magazines, and file the articles according to subject matter. Since the writer has specialized in the field of sewage disposal, his personal file is predominantly on this subject.

The professional sanitary engineer should take an active part in engineering societies. The ASCE and a number of regional engineering societies, such as the BSCE have active sanitary engineering divisions. The water, sewage, and industrial wastes associations are supported to a considerable degree by sanitary engineers and the meetings and journals present much material of factual interest to them. The young sanitary engineer should himself contribute to the professional meetings and technical press by means of articles and discussions.

Much of the work of the sanitary engineer must be done with public funds. The sanitary engineer is required to meet the public and deal with public officials. He should become well acquainted with the operations of municipal, state, and federal agencies and inform himself as to the laws, codes, rules, and regulations under which his work must be performed.

The professional sanitary engineer engaged in public work must work with politicians but apart from politics. It is generally recognized by those holding either elective or appointive offices that the sanitary engineer provides professional services essential to the public welfare and usually his work is carried on without the interference of politics or politicians. Occasionally a sanitary engineer who has served professionally under one administration finds himself person-non-grata when a new administration takes over. This may be regardless of whether a change in political parties is involved and whether or not his services have been entirely satisfactory.

Activities in the sanitary engineering profession have been greatly speeded up during recent years, primarily because of the water pollution abatement program which has advanced on a nationwide scale. A secondary reason for increased activities in recent years is the large backlog of work to be done which had been delayed by depression and war conditions. While a large amount of work has been done in the abatement of pollution by provision for treatment of sewage and industrial wastes, the work yet to be done will require a constantly expanding force of workers in the sanitary engineering field.

A particular problem in pollution abatement is practically never completely and finally solved. Most municipal and industrial treatment works are designed for partial treatment of a portion of the wastes and for a limited capacity not greatly in excess of that required at the time of the design. Works become obsolete, uneconomical to operate, unable to provide the required degree of treatment, overloaded, or run down to an extent that major changes and additions are required periodically.

There is still a tremendous problem in the treatment of industrial wastes so as to abate pollution of receiving waters.

To the writer, one of the most attractive features of the sanitary engineering profession is the variety and scope of the work involved. Practically every problem that arises has some phase that is new and different from previous problems. It is rarely practical to copy directly or follow previous work.

In addition to the technical education, there are other more general qualifications which are of great importance if the young sanitary engineer is to develop into a leader in the profession. These qualifications may include the following: The development of strong moral and ethical sense; a due sense of responsibility; broad social, political, and economic understanding; a liking for and a willingness to work with people, regardless of race, creed, or color; an appreciation of the importance of the work engaged upon; and a certain amount of drive and ambition, tempered by a proper regard for the rights and feelings of others.

Vice-Admiral John J. Manning, in an address to the Student Chapter Conference of the ASCE in Washington in the spring of 1950, advised the young engineer to enter into the field of usefulness and influence in his community, to recognize that his fellow men can offer him as much as he can offer them, and suggested that humility offers a faster road to success than pride and intolerance.

The fullest possible development of the professional sanitary engineer and the depth of satisfaction he will get out of life will depend as much upon his broad development as upon his technical advancement.

ANTIQUE PRESERVER

An acrylic coating for Nigerian pottery is the new preservative system being tried at a Philadelphia museum. A clear, quick-drying plastic, it is claimed to protect surfaces from moisture, rot, fungus and rust. It's also in use, or being tried, as the final preservative in the Eisenhower Museum (Abilene, Kan.), on 1000-year-old Viking ships in Norway, and on the recently discovered 4700-year-old wooden solar ships of Egypt's Pharaoh Cheops.

MORE FOOD FOR LESS WORK

An hour's work today gets the worker about twice as much milk, lamb and ham as in 1929.

TOOLS OF THE TRADE

Although several plumbers' unions sent Dr. Albert Einstein membership cards following his assertion that he'd be a plumber if he were starting all over, a Toledo, Ohio, company did them one better. The firm sent him a kit of four tools—hand threader, pipe cutter, pipe wrench and vise.

TELEVISED PARKING SPACE

Industrial television is now being used to spot empty spaces in car parking lots and as a classroom aid in teaching dental surgery.

AUTOMATIC FLIGHT AHEAD

Underway is a one-million-dollar project to design comprehensive digital-computer control for high-speed military aircraft and guided missiles. Rapid advances in digital computing make possible new plans for miniature digital airborne computers that will make completely automatic all flight and tactical operations. As compact light-weight packages, these will automatically control simultaneous functions such as flight, navigation, engine and fire control.

INDUSTRY BRIEFING

A new industrial program at a major university is expected to open up direct channels of communication between industry and academic research programs. Subscribing companies will receive information on the college's latest engineering and scientific advances at a nominal cost; university and industrial experts will meet periodically to review fields of mutual interest. The program is the first to be made available to industry.

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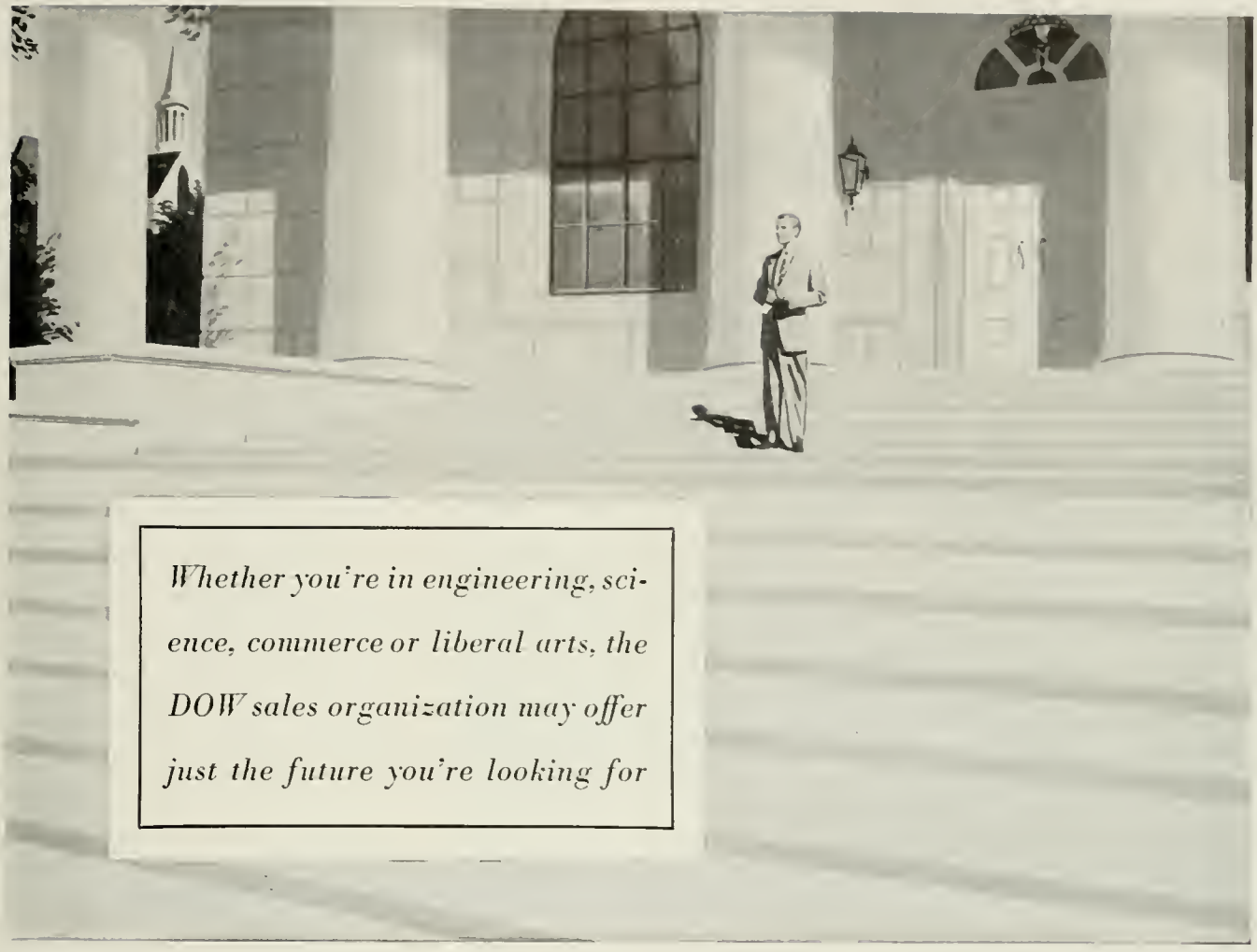
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The Midwestern Universities

Research Association

edited by Larry Kiefling, M. E. '56

On September 27, 1954, the Midwestern Universities Research Association (MURA) became a corporation under the laws of the State of Illinois. The present members are the Universities of Illinois, Iowa, Michigan, Minnesota, and Wisconsin, Purdue University, Indiana University, and Iowa State College. The board of directors of the corporation includes one scientist and one administrative officer from each of the member universities. At the first regular annual meeting of the board of directors, a statement of the origin, objectives, and accomplishments of the corporation was formulated.

During the past decade the frontier of nuclear physics has moved into a new area, where experiments are performed not on the atomic nuclei as a whole but on the individual constituent particles of which they are composed, and on particles which are created through high-energy collisions of subnuclear particles. This new field, which has come to be called high-energy physics, is, and surely will continue to be for a long time to come, the major land of the unknown in physics. But as one horizon after another has appeared in high-energy physics, the investment, both in equipment and in scientific manpower, required for effective work in the field, has come to be beyond the reach of the individual university.

The problem of the great expense, in money and manpower, of high-energy physics can be solved if groups of universities will organize and combine forces for the creation of cooperative laboratories. The effectiveness of this solution has been well demonstrated on the East Coast by the Associated Universities, Inc., in the creation and operation of the Brookhaven National Laboratory. There the control of the laboratory is vested in a board of directors elected by the member universities, and the financial support is provided by the Atomic Energy Commission. The AUI arrangement represents a pioneer experiment, and a successful one, toward the solution of the many problems which attend the support, by the Government, of large scale university research, particularly cooperative research involving several universities. A notable degree of success has been achieved toward extending into the laboratory many of the elements of a free university atmosphere, toward making the laboratory attractive to many scientists from all over the world, and toward preserving the valuable interplay between senior scientists and graduate students.

Until very recently, there has been no similar movement on the part of the universities of the Midwest to combine their forces to create a cooperative labortary for high-energy physics. As a result the Midwest has lagged seriously, relative to both the East Coast and the West Coast, in high-energy physics. The need for such a laboratory in the Midwest is very clear and urgent. There are, in this region of the country, a large number of young physicists who are intensely interested in the field of high-energy physics and who do not have ready access to the necessary facilities.

The first really strong movement in the Midwest toward finding an answer to this need began early in 1953 when some of the nuclear physicists of Midwestern universities constituted themselves an informal committee for the purpose of promoting a cooperative high-energy laboratory and began an intensive series of meetings. From that beginning has grown the present full-fledged Corporation, which has the active participation not only of the scientists of the member universities but of the administrative officers as well. The task to which the committee, and later the Corporation, addressed itself was fourfold:

(a) to determine, with the help of what little experience existed on the subject, the form of organization that would be the most advantageous for the operation of a cooperative laboratory and to bring such an organization into existence;

(b) to determine what environmental and geographical conditions would be the best;

(c) to gather together, immediately, a group from among those young physicists who would be most directly concerned with using a high-energy laboratory, and to set this group to work studying high-energy machines and designing one for the Midwest;

(d) to take immediate steps to raise funds both for the study program and for the eventual construction of a high-energy machine.

The fourfold task described is a heavy one, but the committee has worked for more than a year with the greatest of enthusiasm and vigor. The administrative officers of the universities concerned have not only given their full support at all times, but have actually worked alongside the physicists in thrashing out the many complicated problems of organization. A cooperative laboratory is not yet on the way, but the committee can point to many accomplishments which represent real progress. These accomplishments are described in some detail in the following paragraphs.

A thought foremost in the minds of the members of the committee was that the responsibility for the kind of research envisioned rests, and must rest, upon the shoulders of the universities. The research is of a kind that reaches out very far in advance of the practical applications of today. It cannot, therefore, derive its stimulus from the practical problems or needs and emergencies of the moment, as is true of the type of research done in many industrial and government laboratories. The universities alone have shown the ability, over long periods, to keep alive and flourishing those lines of research which are truly described as basic, i.e., very far in advance of application. It is therefore the unanimous belief of the committee that in the organization for the projected laboratory, the primary responsibility and also a large measure of the control should be vested in the universities, quite aside from the question of the source of funds. Responsibility and control, it is firmly believed, must go together; neither will be effectively maintained over a long period of time without the other.

The organizational scheme of the AUI was used as a starting point and model, and, as it turned out, only minor departures from that scheme were made. An organization very similar to the AUI was completed and it was incorporated under the laws of Illinois on September 27, 1954. Each member university either paid or pledged $10,000 to be used as an operating fund. Considering the fact that all of the universities involved are tax-supported institutions, and that in several cases their joining a corporation outside their own states required an act of the legislature, the successful formation of a corporation attests to the seriousness of purpose of the committee.

It was fully realized that the ques-

tion of the location of a Midwest laboratory would be a complex one, for the reason, among other considerations, that one laboratory already exists in the Midwest which is authorized to enter into cooperative work with the universities, i.e., the Argonne National Laboratory. Nevertheless the committee tried to approach the question on a new basis and to at least attempt to define the most advantageous set of conditions. The importance of proceeding in this manner is pointed up when one recalls that the choice of the location of Brookhaven, which was influenced to a large extent by the availability of a piece of government-owned real estate, proved to be a serious deterrent to the laboratory's development during the early years. The location has only recently been reduced to secondary importance by the uniqueness of the research tools which have become available. The committee therefore takes a strong stand, and will try to maintain it, that a cooperative university laboratory, which is to be built for many decades of use, should not start life with a handicap in location or environment.

The most important requirement in respect to location is, in the opinion of the MURA group, that the laboratory be in a place which is attractive to university scientists. A laboratory is only as good as the scientists who use it. Since a cooperative laboratory would rely heavily upon university scientists going to it for a summer, a semester, or a year at a time, the willingness of university people, and in particular their families, to move to it for these periods is of vital importance. Much would be contributed to the success and value of the laboratory if it could be located in, or close to, an established community of scholars having a variety of fields of interest.

Another important requirement, which is connected with location as well as with organization, is that security restrictions be held at an absolute minimum, making the interchange of scientists and of information with other laboratories and with friendly nations as free as possible.

A study and machine design group, sponsored by the committee and now by the Corporation, and under the chairmanship of Professor Donald W. Kerst from the University of Illinois, has been active since the very beginning in the summer of 1953. With a membership ranging from 10 to 20 from the member institutions as well as from Argonne National Laboratory, the University of Chicago, and Wayne University, it has met for a three-week and an eight-week session at Madison, and for sessions of two or more days at monthly intervals at the various universities. For the present school year it will continue, meeting for two days of every week, with a center of activity at Ann Arbor.

In addition to group meetings, experimental projects on specific problems relating to machine design are being carried on at a number of the member universities. An intensive program using the Illiac (electronic computer) has been under way at Illinois for the past year. Experiments on the design of the radio-frequency accelerator system for a large machine are under way at Iowa State College. Magnet design studies are beginning at Purdue, and electromechanical analot work has been in progress at Michigan for the past year. At Minnesota work is being done on the problem of injecting protons into an AG machine by means of a linear accelerator. The amount of experimental work specifically aimed at the design of a machine is steadily increasing. Scientific contributions by the Midwest study group have already been significant and of value to other laboratories planning high-energy machines. The work is described in detail in numerous technical memos which have been written and distributed over the past year and a half. In addition, the most recent work will be presented in several talks scheduled for the New York meeting of the American Physical Society in January, 1955.

Among the specific accomplishments of the Midwest study group, the one which has attracted the greatest interest is the invention and theoretical exploration of a fixed-field, alternating-gradient (FFAG) accelerator. Briefly, it was found that narrow ring magnets can be made which can simultaneously contain a high-energy orbit, for example a 20 Bev (billion electronic volts) orbit, and a low-energy orbit of about 1 Mev. This means that the magnet can be operated continuously on direct current thus avoiding the complex power equipment needed to pulse a magnet. It also simplifies the radio-frequency modulation, which in the case of the more conventional pulsed magnets must be very precisely controlled to track with the magnetic field. With the new FFAG magnets an arbitrary frequency modulation program may be used. Since the magnet is always able to receive particles, a pulse of particles can be injected as frequently as the radio-frequency modulation cycle can be repeated. Thus the average beam current can be much higher than that from a conventional machine, whose magnet is pulsed.

Professor Ralph E. Meagher examines one of the cathode-ray tubes which composes the memory of the ILLIAC. The ILLIAC is being used extensively on computations of orbit stobility.

About six different types of FFAG accelerators have been worked out. Some involve reverse field sectors and some involve ridges on poles or prismatic edges on magnet sectors. A unified theory which describes all the types so far imagined and suggests other types has been developed, so it may soon be possible to determine the optimum physical design for an ultra-high-energy machine.

It will require more theoretical analy-

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sis in order to determine whether or not the FFAG magnet will have an overall advantage over existing designs in the 20 Bev range; however, it has already become clear that there will be important applications of the FFAG principle to the better-known accelerators at lower energies. For example, betatron acceleration with an FFAG ring magnet used for the guide field will make possible an intensity increase of several orders of magnitude, and existing FM cyclotrons can be changed to give higher current by the application of the spiral ridge form of FFAG poles. An early experimental test of the FFAG principle will therefore be of great importance to several branches of nuclear physics. The MURA group is laying plans for such a test in the very near future at the University of Illinois, using one of the betatrons.

Another activity of the study group which deserves special comment is the development of new computational methods, which make possible rapid experiments on orbit stability, using the Illiac electronic computer. Transformation have been discovered which have not only greatly accelerated the digital computer work, but which have made it possible to explore the more general nonlinear cases which are practically inaccessible analytically. Orbits can now be run through so quickly that the results can actually lead, rather than follow, the conjectures and speculations on modifications of design. Analytical work supporting, and feeding into, the digital computer program is carried out at the Universities of Iowa, Illinois, Wisconsin, Indiana, and Wayne University. This theoretical work is putting MURA in a position to answer some of the difficult questions about general (nonlinear) forces which arise in the conventional AG machines as well as in some of the especially interesting machines recently devised by the members of the MURA group.

The matter of financial support for the MURA objectives has been pursued continuously. So far no support for the construction of a laboratory has been obtained, but adequate support for the study group has been made available from several sources. In the early months of the study program, support was provided by the Atomic Energy Commission through its contracts at Argonne and Brookhaven, and by both the Atomic Energy Commission and the Office of Naval Research through their contracts at some of the universities. Since the spring of 1954 the outside financial aid has been provided entirely by the National Science Foundation.

The member universities have contributed substantially from the time of the early stage of the organization. Faculty members' time has been released freely and in many instances travel expenses have been paid by the universities. The University of Illinois has provided services of its electronic digital computer "Illiac," which has by now has amounted a very large number of hours. The University of Michigan, through its Phoenix Project, has provided a special fund to cover the expenses of its scientific participants and for experimental work at Michigan. To provide for business expenses of the Corporation each of the eight member universities has contributed $5,000 and has pledged another $5,000.

Professor Donald W. Kerst with the original betatron which he constructed at the University of Illinois in 1940 and the 300 MEV betatron.

Will You Become a Good Engineer?

by D. B. Keyes

You young men will be given much sound, practical and concrete advice about how to look for and how to secure a job. I am going to take the calculated risk of telling you bluntly what is on the minds of many of us when we evaluate you as potential employees. We disguise this interest with carefully worded sociological and psychological questions, but what we want to know, what we must learn, is: Do you really want to be an engineer?

There are many opportunities today for the young man who sincerely loves his profession and can demonstrate his abilities. There always are. The men I know who graduated during the early thirties in the midst of the depression thought they had a pretty tough time, but 90% of them were located in positions within six months after graduation. Many of them now hold very responsible positions in industry and in the technical world. Their chief characteristic then, as now, was that they really loved their profession.

Today, however, there seems to be generated in the minds of our college graduates, especially our engineers, a philosophy peculiar to the times. Personnel directors interviewing men in our colleges tell me that you are inclined to inquire first of all, not about the character of the job, but about pension plans and fringe benefits.

Even if you have a pension in your old age, it will probably appear inadequate from your viewpoint. A research engineer who recently retired as the executive of a large corporation told me that now, although his retirement allowance is $45,000 a year, he is forced to continue to work for a living. Over the years he has acquired some rather expensive tastes and; because of the tax situation and inflation, he cannot maintain his standard of living on his present pension, even though the size of his pension may look large to most of us.

Financial security must not be your

primary objective. A rewarding career is dependent upon this fundamental consideration: Will the type of engineering you have elected offer you the incentive, the curiosity and the urge to work hard and "go places."

It has been my privilege to know quite a few distinguished engineers. Looking back over the years, I know of only one of my acquaintances who seems to have acquired real financial security. The state takes care of him and will do so as long as he lives. He paid a very high price for this security, but in fairness to this individual, I must say that he did not wish it this way.

On the other hand, taking a typical example of one of my friends who has been very successful in the engineering field, I know of no time when he was actually financially secure. After working up as general manager of a company, he decided that the future of this company was not too good; it was in a very specialized field. He then became a college professor.

It was quite obvious to me that, although he was one of the finest professors I had ever had the pleasure of listening to in the engineering field, he would be unhappy if he stayed in that position too long. Evidently, his thoughts were along similar lines, for during World War I he became the president of a war company. With the aid of a very competent staff of young people, he developed this company to such an extent that it became one of the greatest chemical companies of its day. The financial backers of this company, however, did not appreciate the vision of my friend. When he discovered that he could develop the company no further, he promptly lost interest, resigned, and became a consulting engineer.

It wasn't long before another concern, wishing to develop the chemical end of their business, hired my friend. For many years he gave all that he had to the development of this group. His success was phenomenal, and today this company is one of the truly great chemical concerns in the world. He remained active, upon request, long after his retirement age. When he finally retired, he still retained an active interest. Today he is still active and still very happy.

At no time in his career, as far as I know, has he ever sought to work for his own financial security, but has given his all to the development of every organization with which he has been connected. It should be remembered, too, that he liked what he was doing, and when he didn't, he changed to a new job that he did enjoy.

Shortly after World War II, another friend of mine, prominent in war work as an engineer, joined one of the smaller research units of a large company. After three months he quit. He could not stand the "atmosphere." He found men in their early twenties who were not interested in creating anything. Merely interested in their pay, their fringe benefits, and their old-age security, they were actually looking forward to the time when they could retire and quit working for a living. He told me that this atmosphere just got on his nerves, so much so that, although he was older than his colleagues and liked his particular job, he could not work there any longer.

One of the best examples of a successful industrialist, an engineer whom I knew in the old days, was Herbert Dow, the founder of the Dow Chemical Company. If one reads the history of this company, one is impressed with the fact that its founder not only was seemingly uninterested in personal profit, but in the profits for the company. He took the attitude that a company's growth depended on its ability to produce new products useful to the public at a price the public could afford to pay. He apparently reasoned that if one was successful in creating these new products at a price, the profits would come automatically—which they did. Today, the Dow Chemical Company stands out as one of the truly great creative and profitable enterprises. I doubt whether the late Herbert Dow ever envisioned the enormous growth that has taken place as a result of his simple and practical principle.

The same principle was applied by another friend of mine, who started his first company with $243 when he was seventeen years of age, and developed an "empire" worth, at the time of his death, over $25 million. This man told me on several occasions that the love of creation, and not of money, was his guiding principle. He told me that large profits obtained in a single year through the sudden development of a new product were always embarrassing to him, as his stockholders expected him to reinvest this sum immediately to make an equal percentage profit—something that usually cannot be done.

Permit me to point out that the philosophy of these two men, so dissimilar in background and education, was a desire to seize every opportunity to create for the benefit of the public. They obtained their enjoyment in hard work and during their working hours. If either one of them at any time had fringe benefits of any description, I certainly do not know what they were.

The enormous amount of energy Edison spent not only in creating but in promoting electrical engineering developments in order to satisfy the public is still appreciated. Many years ago the courts decided that the Edison patents on the moving picture machine were the basic ones, although three satisfactory moving picture machines had already been invented and developed by other persons prior to Edison's. But these three had been "abandoned." The court pointed out that Edison had not abandoned his invention but had spent an enormous amount of time, energy, and money in seeing to it that the public received the benefits. It was no more than human for the court to agree to give credit to Edison rather than the prior inventors. Creation for the benefit of the public is what the public wants and incidentally, what they are willing to pay for.

One must not only love engineering, but use one's knowledge and energy for the creation of something that is directly or indirectly of benefit to all.

My suggestion to you who are graduating from our engineering colleges is to be certain when you discuss a position in industry to find out just what it is you are supposed to do on the job and then determine for yourself whether or not you would enjoy doing that particular type of work.

If by chance you know what you would like to do, be sure to tell the personnel man your thoughts. He is eager to place you in the position in which you will do well, for his success as a procurer of young engineers depends on his ability to discover your basic interests and to place you in the position which will give you the opportunity you desire.

The capable young man with a sound educational background, with the desire to augment his knowledge throughout his lifetime, with a love for his work, and with an ardent desire to create for the benefit of mankind, should find unlimited opportunities in the engineering fields.

Do you really want to be an engineer?

"May I have this dance?" asked the freshman.

"I'm sorry, but I never dance with a child," she said with a superior sneer.

"Oh, a thousand pardons," he said, "I didn't know your condition."

* * *

Patient: *"I'm in a terrible mess; the doctor said the only way to cure rheumatism is to stay away from dampness."*

Friend: *"What's so t o u g h about that?"*

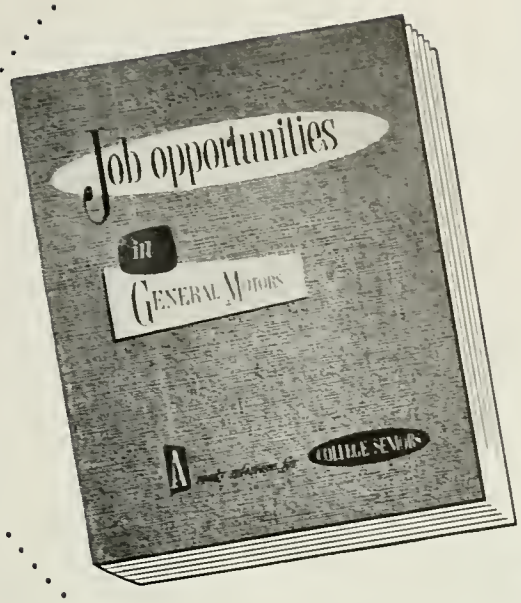
Patient: *"You don't know how silly I feel when I sit in an empty tub and go over myself with a vacuum cleaner."*

* * *

The editor of this column points with pride to the clean, white spaces between these jokes.

* * *

An extreme optimist is a man who sits in the back of a burlesque house and winks at the chorus.



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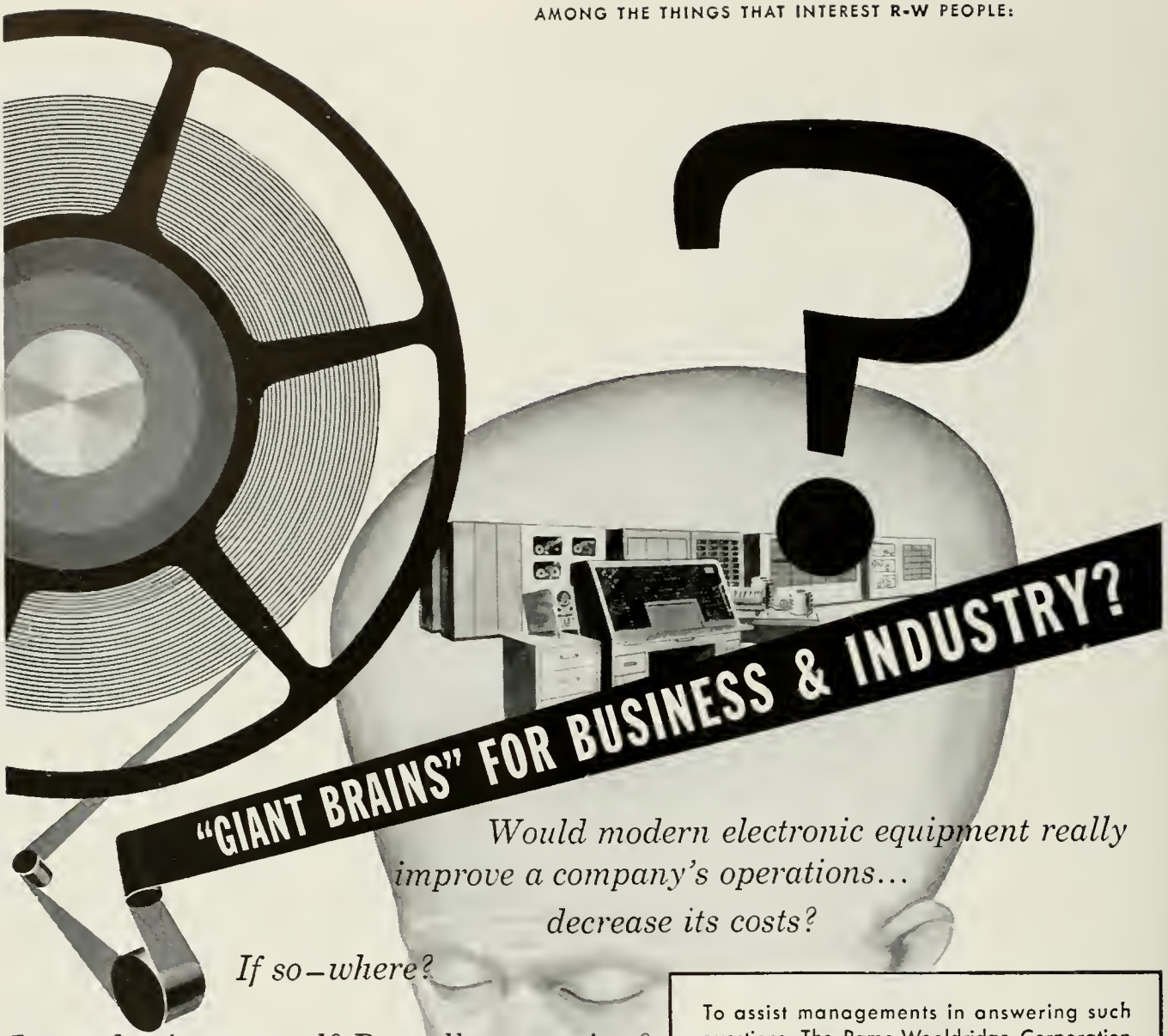

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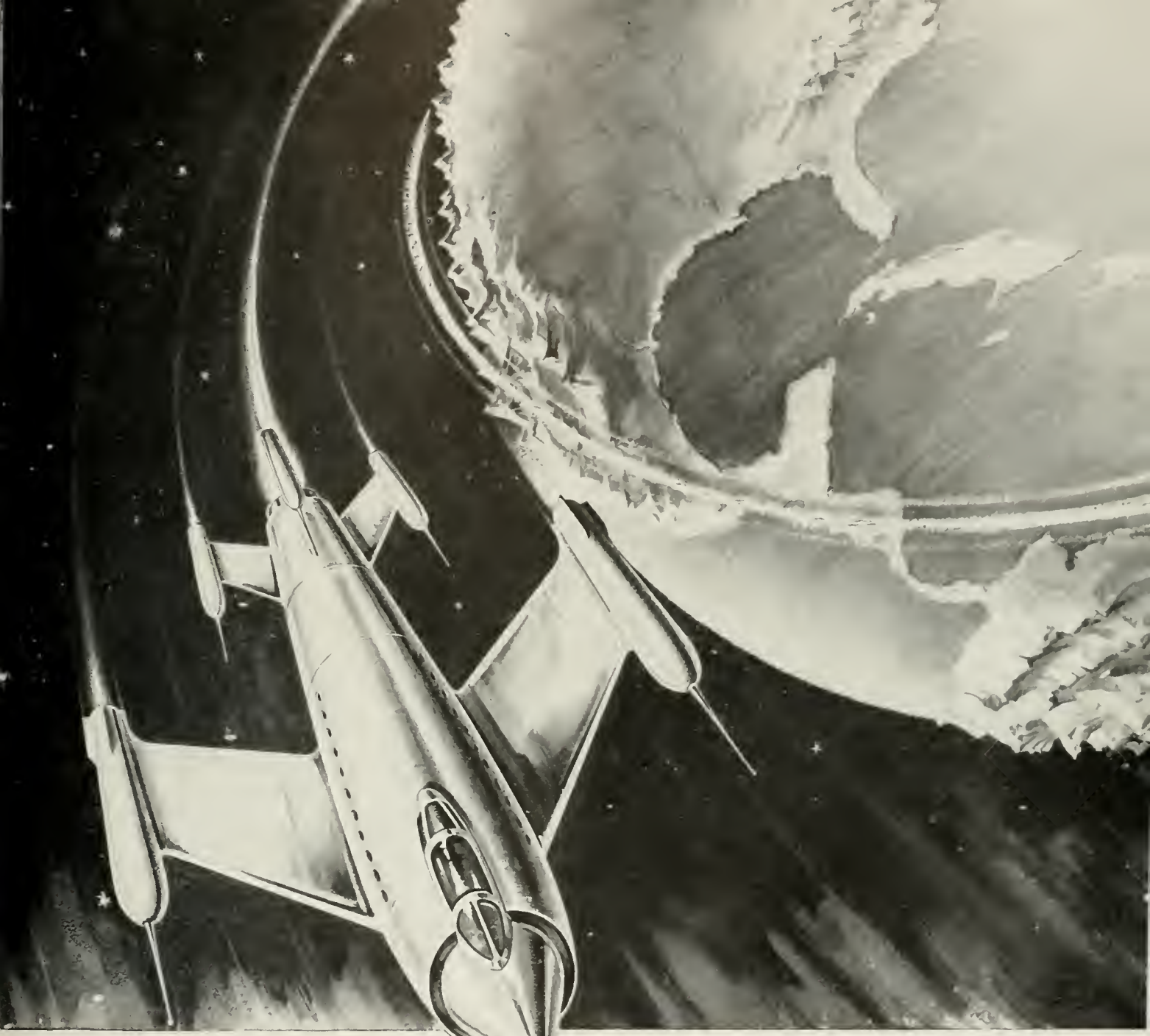

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Germany's Greatest Ace

by Jim Piechocki, Aero E. '56

His name was Richtofen. The Baron Manfred von Richtofen. Most people have never heard of him of his exploits, but in his day he was the greatest pilot ever to slide into a clockpit and snap on a kepi. More than that, he was the most feared man in the skies during the courageous days of flying, the World War I era. The eighty planes he claimed

JIM PIECHOCKI

Jim, a junior in his second semester on this campus, has previously written articles for the TECHNOGRAPH while at Navy Pier. He is now busy in orgonizing an openhouse program for the Aerodynamics department.

in battle still is a record. Think of it. Eighty British and French planes shot down by one man!

His day was the day of dancing biplanes, struts and wire braces, flapping fabric, and open cockpits. His secret was to attack by surprise. "Just let me get above and to the rear of them and they are mine," he once said to his fellow officers of the German Imperial Air Service. Richtofen fought because he loved to hunt. The hunting instinct and a great love for horses was instilled in him by his father, a major in the reserves with a great military past of his own. The little village of Schweidnitz, Germany, in the shadow of the mighty Uhls, the birthplace of the Baron, was the scene of many of his youthful hunting victories. His home later became a shrine filled with many trophies, which included everything from the head of a wild bull to the battered pieces of British aircraft.

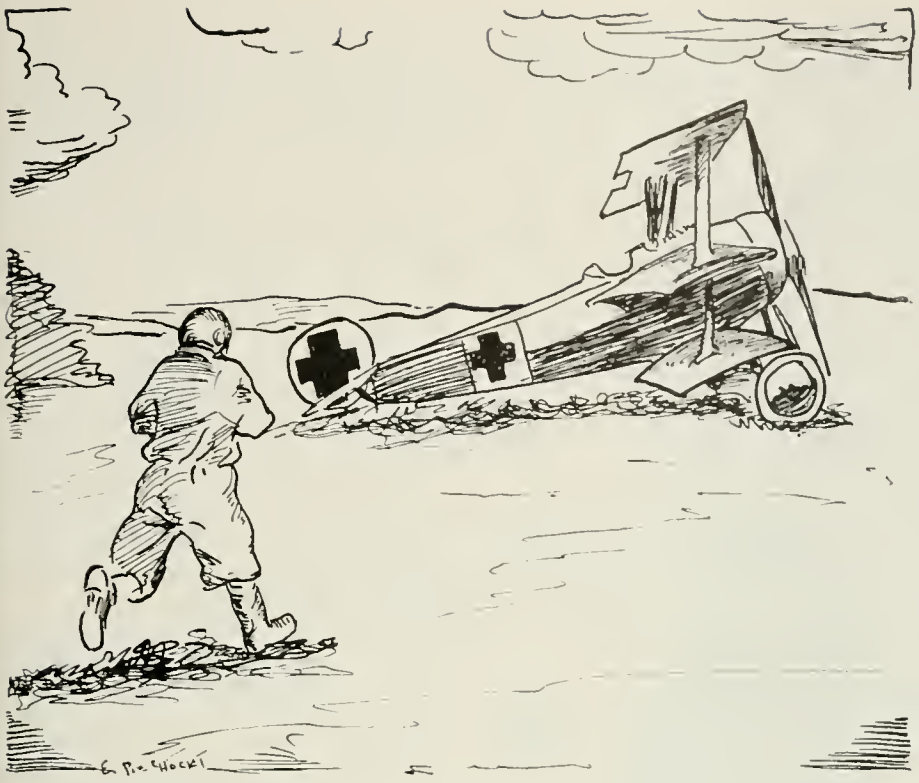
He was not always a flyer. His great love for horses prompted his enlistment in the German cavalry. When the great war began, the Baron participated in the siege of Kielce, one of the earliest attacks of 1914. But he soon became disgusted with cavalry life, for he found that all glory of the charging horde was submerged in the trivial administrative duties of policing a town of illiterate peasants. Weeks later, he was transferred to the trenches, where he won his first decoration, the Iron Cross. Still dissatisfied, he applied for flight training. It was rumored that adventure was to be found in the air and this was what the Baron wanted. He got his transfer, and by December, 1914, he was flying as an observer in the old "applebarges" or reconnaissance bombers over the Belgian front. His duties were that of watching the instruments, checking maps, and doing everything possible to lighten the burden of his pilot, Zumer, who literally had his hands full in keeping their clumsy Albatross aloft.

These were truly the chivalrous days of flying, for enemy planes usually circled battle zones alongside each other for hours without any idea of attacking. Then someone got the urge to take a carbine aloft and try their luck with a few pot shots. Richtofen tried it too. While flying one day over the Champagne front, his pilot pulled their two-seater alongside a large French Farman reconaissance ship. When the French observer saw the Germans' intention, he produced a carbine of his own and soon both ships were exchanging broadsides like two galleons of old. Suddenly the Farman dropped into a spiral dive, pancaked on the rugged terrain below, and rolled into a shellhole, finally coming to rest with tail pointing skyward. For the Baron it was a thrill beyond description, a new hunting victory. What a story this would make back at the airdrome tonight! It was more than a story, however, for it raised secret hopes in the Baron for another transfer, this time for pilot training, and the smaller, faster *eindecker* scouts. Zumer began readying Richtofen for his first solo.

It was a cold, cloudy day in October 1915, when Manfred stepped alone into the cockpit of a plane for the first time. A few officers stood at a distance and watched the plane roll slowly along the runway and lift itself into the air. After the required number of passes, Richtofen brought the ship in for the crucial test, the landing. The craft glided in at a steep angle, slapped the runway, and bounced crazily along until a wingtip scraped the turf. The son of nobility, the man who was to become Germany's greatest ace, the Flying Uhlan, the Circusmaster, the Red Knight, had crash-landed. It was only through the patience of his superiors that Manfred achieved pilot's rating on Christmas day, 1915.

By March, 1916, Richtofen was back at the front. Almost immediately he got above and to the rear of a speedy little French Nieuport and brought it to the earth in flames. He accomplished his first kill under the watchful eyes of Boelcke, the German god of the skies with over a score of victories to his credit. Richtofen secretly wished he could fly on the very active eastern front, where it was rumored that the British were inflicting heavy casualties in the air. Only a few German pilots, Boelcke being one of them, were having any luck against the superior forces of the British. But this was soon to change, because Boelcke himself was organizing a squadron of crack pilots whose main purpose was to smash enemy air superiority to the East. The great Boelcke himself visited Richtofen in his quarters and invited him to fly in the new squadron. With a hearty laugh and a sudden clasp of hands, Richtofen became a member of the most feared group of fighter pilots ever known—*Jagstaffel No. 2.*

Under the watchful eyes of Boelcke,



On September 27, 1917, Richtofen ran for the first time to his new ship—the all-red, triple decked Fokker tripe.

Manfred, a good pilot, became a great one. He listened carefully to the wise suggestions of Boelcke, whom he deeply admired. Boelcke had a quality of personal magnetism which made him well liked by both enemy and ally. He spent many hours visiting the hospitals which held many of his crippled victims. And he and the Baron began a reign of terror from the very first day that his staffel flew into the Somme basin in late September, 1916. On their first sortie, Manfred bagged an old British F. E. He landed afterwards and reached the battered craft in time to see the observer die. The pilot was mortally wounded. Back at the airdrome and amidst a wild celebration, Richtofen slipped away and went to a small hospital in Cambrai. Behind the building he paused before two fresh graves and bowed his head in admiration. Two years later Englishmen would bow their heads in his honor.

The war was going in favor of the Allies. By late October, 1916, the British had attacked Albert and were victorious on the Commercourt salient. With a new frenzy they hurled their forces into battle at Bazentine, Pozieres Ridge, and Delville Wood. Like thousands of ants they swarmed into Thiepval and the Translay Ridges, and Richtofen sent his sixth victim hurtling to German soil. On October 28, tragedy struck the staffel. The great Boelcke was killed in an aerial mishap when he collided in mid-air with a plane from his own squadron. The country mourned the death of their hero who had forty enemy planes to his credit, and had flown by the side of and was decorated with the famous Immelman. Boelcke was buried with his highest decoration, the *Pour le Merite*. High over Cambrai British planes dropped wreaths in his honor.

The Baron's eleventh victory came November 23, and with it he avenged the death of Boelcke, for his victim was Hawker, Britain's greatest fighter-pilot. It was a gruelling, circling skirmish that started at 11,000 feet and ended only a few feet above German territory. Manfred landed near the battered Vickers scout. He removed Hawker's guns and had them placed in his home at Schweidnitz. He commemorated each of his victories with a tiny silver cup inscribed with the type of craft downed and the date of the encounters. At this point, Manfred's brother, Lothar, was transferred to the Air Service and began flying with the Baron, who was now the proud wearer of that blue-pointed cross with the golden eagles— the *Pour le Merite*.

Richtofen's aerial success now came rapidly. He was placed in command of the squadron, which was renamed *Jagdstaffel Boelcke*. By December, 23, he had accounted for sixteen enemy planes. Now the color rage began. Pilots had been experimenting with various color schemes in an effort to camouflage their craft. But here the Baron made a bold stoke on the side of individuality. He ordered his DIII Albatross scout painted a brilliant red. Every strut, brace, and hidden corner was covered with the flaming hue. Now those plucky sons of England would know whom they were fighting. Others followed suit. German pilots had their planes painted with shining blues, yellows, and whites. Combinations of red with green or blue noses, black and white checks, yellow and black zebra stripes, and multi-colored spangles were used. But the all-red scheme was reserved for the Baron, and it earned him the title of the Red Knight of Germany.

Now badly outclassed in the air, the British came on in every conceivable type of ship that they could get in the air. They used the slow and clumsy F. E.'s and the venerable R. E. 8's, which they nicknamed the "Harry Tate." "We were cold meat," cited one British pilot, "and the worst part of it was that we knew it." German pilots, with their fast, single-seater bipes, capitalized easily. Early in 1917, Richtofen was placed at the head of newly organized *Jasta 11*, a collection of battle-wise old hawks who roared into the air for the first time on January 23. Within a month he had increased his magic total to twenty-five, interrupted only once by a British bullet in his engine behind his own lines. By March 22, he had downed his thirtieth.

And still the British came on. In the battle of the Ancre salient, the Germans lost heavily. They were in a general retreat along the Ancre, and the British were approaching before Baupame. Continuing their drive, German retreat was forced along the 100-mile line of the Noyon salient from north of Arras to near Reims, to the prepared Hindenburg line. The plucky sons of England, still hopelessly outclassed in the air, continued to carry the war to their foes, but just as coming events cast their shadows, so too was Richtofen beginning to detect the end of German air power. New British planes were on the way. His thirtieth victim was a new Spad claimed after a long circling battle. Yes, the planes of John Bull were improving.

The famous men of *Jasta 11*—Wolff, Allmenroder, Lubbert, Schaefer, and the two Richtofens—seemed unmindful of the improvement in enemy craft. During the month of April, 120 British planes were shot down, as compared to thirty for the Germans. By April 8, Manfred's total had run up to forty. He had equalled the record of Boelcke, and the whole nation awaited his next victory. His superiors were pressing him to take a vacation after his forty-first success. It was in almost complete defiance of "the records" that Manfred flew off and returned on April 11, modestly announcing that he had scored a "triple." He

had effectively evaded his superiors' demand that he rest. That evening at the airdrome, his *staffel* toasted him a countless number of times, and the Baron retaliated with a toast to Wolff, who had gotten four English planes that same day. And far behind the lines, a Berlin jeweller put the finishing touches on Manfred's forty-third little silver victory cup.

Now the tide of battle suddenly changed in the air. With "bloddy April" over and the Baron personally accounting for twenty-one in that period, a decided change came about. The spring line of British planes reached the front. These included the Sopwiths and remodelled Nieuports, very fast little scouts which made the Baron's battles just a little longer. Faster turns, a few more tricky twists, and victories now came only after great effort. The Baron, however, still managed to catch up with the Sops, and when he downed four in one day at the beginning of May, the Kaiser himself telephoned and offered his personal congratulations.

On May 1, Richtofen took the vacation demanded of him. Far behind the lines word came of his arrival and when he reached Cologne he was met by hundreds of officers who smartly saluted him and offered their congratulations. Pretty frauleins presented him with wreaths of flowers and were delighted with this shy young man who blushed furiously in their presence. The Baron was then whisked off to see the Kaiser, who congratulated him on his twenty-fifth birthday. He then met with von Hindenburg, von Ludendorf, General Heppner, Balin, and Helfferich—when who were shaping the fate of Germany in the war. At her own request, the Baron visited the Kaiserin. The empress was very curious as to how his plane worked, and the Baron took great delight in explaining the intricacies of flight to her majesty. Next he flew to Freiburg where he hunted pheasant and red elk. It was here that he learned that Lothar had fallen into a British aerial trap and was shot down seriously wounded. Lothar, an ace in his own right with twenty planes to his credit, was secretly admonished by the Baron for his stupidity.

When the Baron returned to the front, he found the scene changed. Familiar faces were missing. The news of Lt. Schaefer's death shocked him. Wolff was dead. On June 17, Zumer, the man who taught Richtofen to fly, died in a fall from his plane. Young and inexperienced men were filling the spaces vacated by his old friends. Tactics were changing also. The German government claimed that individual combat was proving too costly, hence they formed the *Jagdsgeschwaders,* or massed flights which roamed the front like a pack of hungry vultures. These flying circuses, as the British called them, created new aerial combat techniques. Any poor souls who happened to run into one unescorted usually encountered a dizzy blur of biplanes circling madly around with his own tail as the prized object. These circling battles received the name of "dogfights." Richtofen was placed in command of a newly formed massed squadron, and he immediately resumed his winning ways at his new post of "Circusmaster."

On July 6, Richtofen's circus spotted a flight of six F. E. 2's which had strayed beyond their own lines. The Baron led the attack with forty Albatross bipes following. He turned head-on into one stray with his twin Spandaus guns chattering away. He saw fabric fly up around the enemy observer. Then it happened. A burst from the F. E. exploded in his face and all went black. With his engine dead and his sight practically gone, the Baron glided his plane earthward. The mighty Circusmaster, conqueror of fifty-seven planes, hit the ground sharply. He awoke several hours later in a hospital to find that his skull had been creased by a British bullet. It was his first and only serious wound of the war. After three weeks of convalescence, he was back at the front, a changed man. His confident attitude was replaced by an air of grim caution and the horror of defeat, previously unknown to him, tugged at his mind. A white bandage could be seen beneath his kepi.

Manfred von Richtofen, Germany's greatest ace.

And still the Allies came on. The English had captured Wytschaete, and activity was renewed in the Ypres sector. The battle in the mud of Flanders raged on. And the Baron claimed number fifty-nine on August 26.

At this time, young Tony Fokker, Germany's brilliant designer, presented Manfred with his latest model, the famous triplane. After testing the triple-winged ship, the Baron said he liked it and would use it. It was a marvelous craft, highly maneuverable, and was naturally painted a brilliant red. It was on September 2, 1917, that Manfred eagerly ran to the ship where a mechanic had finished preliminary preparations. He took his new tripe up and headed with *staffel* toward Zonnebeke. There they spotted a lone "Harry Tate" and the Baron dropped down very close and to the rear of it. The British observer, never having seen an enemy triplane, thought it was a Royal Navy craft and waved a salute. Richtofen pressed the trigger of his twin Spandaus and raked the British plane with bullets. His sixtieth victim fell in a familiar spiral dive. The Berlin jeweller made another little silver cup, the last one for the Baron in the face of Germany's rapidly dwindling silver supply.

Now the British made a daring move. The Royal Flying Service was combined with the Royal Naval Air Service into one air arm and called the Royal Air Force. The R. A. F. was placed under the control of a special secretary of state whose status was equal to that of the head of the army or navy. Women were placed in mechanics' positions in an effort to release more men for air service. Investigations pried into military affairs, and inquiries were held concerning the worthiness of certain British craft. Aeronautical research was directed toward the improvement of the scout plane. Sopwith Camels and S. E. 5's were developed. The Sop was then improved into a type called the Dolphin, and later into the English pride of the air, the Snipe.

Russia surrendered to Germany, and on March 18, 1917, the Baron bagged number sixty-six, a speedy Sop Camel. By March 21, Germany's big push was on. They overpowered British forces at St. Quentin and roared down the road to Guiscard. They swept past Ham and Perone. They battled their way through Bapaume, through Boyelle, and on to the river Cojeul. The air war over Picardy was savage, and the Baron, back to his old tricks in familiar territory again, was showing particular interest in the new Sops. His black list now contained seventy-three markers.

A running account of Richtofen's next spurt of successes reads like this: March 28, number seventy-four; April 2, seventy-five; April 6, seventy-six; April 7, numbers seventy-seven and seventy-eight. Just thirty-five minutes after his last victory of that day, he turned on a Sopwith Camel piloted by an eighteen-year-old Englishman and destroyed it. It was his eightieth and last victim. The reign of the Red Knight was at an end. The next Camel would get him.

Captain Roy Brown R. A. F. Squad-

Donald C. Pote asks:

What bearing would my field of training have on my assignments at Du Pont?

DONALD C. POTE will receive his B.S. degree in Mechanical Engineering from Princeton University this June. He's been quite active in interclub athletics—football, basketball and baseball—and served a term as Club Athletic Director. He's also found time to work on "The Princeton Engineer" as Associate Editor. Right now, Don is making thorough plans for his employment after graduation.

CHARLES H. NOREN received his B.S. in Mining Engineering from the University of North Dakota before he entered the U. S. Air Force. Later he returned to school for an M.S. from the Missouri School of Mines, received in 1948. During the course of his Du Pont employment, Chuck Noren has had a wide variety of job assignments. At present he is engaged in a fundamental research project concerned with commercial explosives at Du Pont's Eastern Laboratory in Gibbstown, N. J.

"Chuck" Noren answers:

The answer to that is easy, Don, if you mean *initial* assignments. Generally speaking, a graduate's first assignment is influenced by his previous training and his expressed interest in a particular type of work. Whenever possible, Du Pont assigns a man to the type of work he is trained for and wants—he'll do better in any field if he's highly interested. For example, my master's thesis was on the use of explosives, and my first Du Pont assignment was a study of the efficiency of explosives.

But experience on the job really constitutes *new training*. You learn about other branches of science and engineering—you broaden your horizons through daily contacts with men having other skills. The result is that arbitrary divisions between technical branches gradually dissolve, and you become ready for new assignments and new responsibilities—even outside your original field. In my own case, I developed quite a bit of skill in mechanical and civil engineering techniques when I was called upon to supervise the "shooting" of an experimental tunnel for the evaluation of new explosives—even though my original training was in mining engineering.

Of course, specialization in a definite field may be continued if the man specifically wants it and reveals a talent for it. The best opportunities for that are in research and development. Naturally, the value of this kind of work is also recognized at Du Pont.

So, no matter what your initial assignment may be, Don, Du Pont is anxious to bring out your best. A good rule to remember is this. A graduate's *first* assignment is often necessarily based on his field of training and his degree, but his subsequent progress at Du Pont is *always* based on his demonstrated ability.

NOW AVAILABLE for student ASME chapters and other college groups, a 16-mm. sound-color movie—"Mechanical Engineering at Du Pont." For further information write to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Bldg., Wilmington 98, Delaware.

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BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

WATCH "CAVALCADE OF AMERICA" ON TELEVISION

ron 209 was a very sick man. The rigors of two daily flights against the circuses had shattered his nerves. But his troubles were momentarily forgotten when he saw "Wop" May, and old buddy from his training days, walk into his room. They laughed together and Brown soon discovered that May had been transferred to his squadron but was grounded for failure to report to duty on time. May begged his friend to use his influence and talk the "old man" into letting him fly the next day. On April 21, 1917, at 10:30 a. m., fifteen cherry-nosed Camels darted across the runway at Bertangles and headed east. Brown was in the pack and on his right was a young lieutenant named Wilfrid "Wop" May.

In a matter of minutes they spotted trouble. Flying at 15,000 feet, they saw a group of "Harry Tates" being mercilessly attacked by four Fokkers two miles below. Should they drop down to help out or were their more Fokkers about? It was Brown's decision. He wagged his wings, kicked over the rudder, and nosed his ship down. When the fifteen Camels were 1,000 feet above the melee, another swarm of Fokkers, twenty-two of them, swooped from out of nowhere and joined the scrap. The dogfight was on. May, warned to stay off at a distance if serious trouble was encountered, singled out a stray, got on its tail, and finally sent it down in flames. Brown, in the meantime, found himself in the middle of a mess looking for a way out. But the strong east wind had already pushed the huge, circling battle to the west and the German ships were beginning to turn and head for the safety of their own lines. But one Fokker, a bright red triplane, stayed behind. Brown spotted the red ship on the tail of poor May, who just wouldn't stay away from trouble. By the time Brown caught up with the speeding pair they were deep in British territory. The trio were travelling at an incredible speed and very low over the terrain when Brown opened fire on the triplane. The red ship veered off suddenly and went sprawling to the earth in a grinding crash. This was the way the Baron died near the village of Sailly le Sac, in the valley of the Somme.

That same afternoon a small group of soldiers carried Richtofen's body to a small cemetery near Bertangles. A freshly dug grave awaited. Shells boomed in the distance as an English chaplain spoke a few prayers. An officer barked a command and the assembly of soldiers snapped to attention. Rifles were raised. Three vollies rang out from the guns of the men the Baron fought so admirably. In a few months the war was over and the man who once was the toast of Germany became just another casualty.

Meet Mr. Bunche

by Frank Krbec

Ralph Johnson Bunche was born in Detroit, Michigan, on August 7, 1904. His mother was a musician and his father, a barber. The untimely death of his mother sent Ralph to live with his aunt in New Mexico. His devoted love for learning inspired him to enroll in college and his choice was the University of California at Los Angeles. With him he carried an outstanding record from his Detroit high school and soon it became evident he would do just as well in his new location. You can't keep a man like Ralph Bunche down. No task became difficult when he assigned himself to the job. Whether he was doing outstanding scholastic work or out on the field distinguishing himself in sports, he was an example to watch. He got through college holding several jobs as a janitor, part-time carpet layer, and assistant in political science along with a few scholarships. He graduated "summa cum laude" from the University with a Master's degree and was a member of Phi Beta Kappa.

His career was a brilliant one. For his doctor's thesis he went to Africa to write a prize winning paper on the governmental aspects of several of the mandated countries. He accepted the opportunity to teach after receiving his Ph.D. from Harvard in 1934. Turning from the academic world he accepted the post of the secretarial of the United Nations Palestine Commission regarded as the most important and critical assignments in U. N. history. Before this appointment came, Bunche served with the U. S. Army supplying much needed information concerning the people encountered within the continent of Africa. He was an authority on non-self-governing territories. Bunche came to the State Department where he had held several offices, including that of associate chief of the Division of Dependent Area Affairs. He was the first negro to hold an important "desk job" in the State Department. He was the director of United Nations Trusteeship Division and a University professor. In the former position he served with the U. N. special committee on Palestine, which investigated, in the summer of 1947 the Holy Arab-Jewish problem and recommended partition in its majority report. In 1948 he was named acting mediator of the commission to succeed the late Count Folke Bernadotte. Mr. Bunche is a born administrator and highly respected government head. Throughout his career he has used his tremendous knowledge and skills of government to promote better relations between the U. S. and rest of the world. It takes a highly trained man to sit down at the conference table and iron out difficulties which could lead to war. In this spot, one must have all the qualities of a diplomat plus the uncanny ability to know and understand the other man's exact feelings on the subject. It is in this capacity that Mr. Bunche has served with such an outstanding record.

Ralph Bunche had no doubt great obstacles to overcome on his way to fame. He has made a name for himself in government as Fermi has in atomic physics or Hemingway in literature. He is a striking example of American opportunity put to good use. America is certainly proud of Mr. Bunche. In his own circle, he has a wife and three children. He spends most of his time with them and watching Jackie Robinson play ball.

Last year, Mr. Bunche was on our campus delivering the keynote speech of the human relations conference sponsored by the Hillel Foundation and coordinately organized by Mirian Sheldon, Dean of Women. He is probably the one man who knows more about human relations than anyone else. We salute citizen of the world, Ralph Bunche.

DIAMOND NEEDLE BOOM

Diamond phonograph needle sales have jumped more than tenfold in the last six years. In addition, about 70,000 diamond needles are sold each year for use in disk and belt-type office dictating machines. An estimated 40,000 needles per year are sold for original equipment and replacements in juke boxes.

GETTING COLDER

Manufacturers' shipments of room air conditioners for 1954 were about 1,230,000 units. This compares with 1,044,691 shipped in 1953, or an increase of 18 per cent. Although room air conditioners have been sold for over 20 years, 90 per cent of all units have been sold in the last five years.

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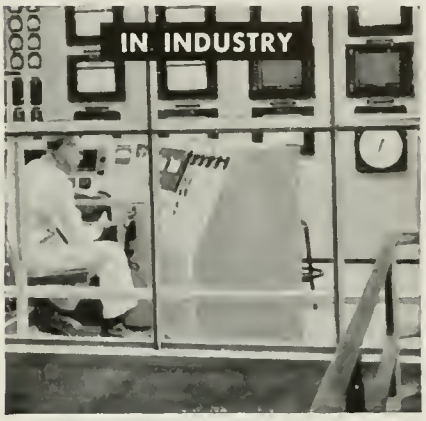

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As one of these field engineers *you will become familiar with the entire systems* involved, including the most advanced electronic computers. With this advantage you will be ideally situated to broaden your experience and learning more quickly for future application to advanced electronics activity in either the military or the commercial field.

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Relocation of applicant must not cause disruption of an urgent military project.

Selecting Your Employer

by R. H. Earle

The engineering student who is about to graduate and start on his working career often is confronted by so many job openings that he has difficulty in selecting the best one. Obviously, he wants to choose the position which offers him the best opportunity to develop his talents to the utmost, contribute the most to the organization he selects, and receive in return the greatest compensation in the form of recognition, personal enjoyment in his work, and his salary.

The young engineer's problem bears a striking similarity to that of a man who has some money to invest on a long-term basis and wishes to purchase common stock in the business concern which will give him the greatest return over the long pull.

Investment counsellors have some guides that they follow in advising prospective investors. The counsellors point out, as good investment possibilities, companies that are in a growing and an essential industry, have financial stability, and are operated by a seasoned management. It is interesting to see if these same guides could not be followed by the young engineer selecting a job.

One of the first things the young engineer and the investor have to decide is to what degree they wish to speculate because there is no such thing in the business world as absolute security, either for the money invested in a business or for the men that make up the organization.

The investor who is young, healthy, and financially independent, even during emergencies, can afford to take greater risks with his common stock fund than could, for example, an older man with family responsibilities, limited resources, and few years to recover from any financial losses he might experience. Likewise, the young engineer who is healthy and financially independent can afford to take a greater risk in the selection of a job than a young man who is married, has a family, and is solely dependent upon his monthly salary.

I believe that most young engineers and most long term investors in common stocks can take a so-called "businessman's risk," because they are both looking for a moderate amount of security. Engineers and investors seek an opportunity for progress through growth of the company with which they are associated.

At this point it might be interesting to trace the history of a typical company or typical industry in our economic system today.

The usual pattern is for the early stages of an industry to be quite hazardous from a financial standpoint and very speculative for both the investors and the employees. For example, the very earliest railroads that were built shortly after the steam locomotive was invented were very hazardous ventures and, undoubtedly, much money and many jobs were lost in the early stages.

Very often in these early stages there is not a market yet for the product being sold. Further there has not been engineering design data accumulated to the point that a thoroughly satisfactory product can be designed and produced. The result is likely to be frequent customers' complaints and consequent losses from replacing defective products. As the industry and the companies in it gain more experience, establish a market for the product, and accumulate know-how and facilities, a reasonable measure of stability gradually evolves. The industry then enters a so-called "growth" period. If the product or service has a wide appeal, the market develops rapidly, and for some years shows no sign of saturation. During this period the industry and the companies in it are likely to grow at a more rapid rate than business in general.

Gradually as enough companies get into the business to supply the market adequately, the market approaches a ceiling and is ultimately made up of two parts: first in the replacement of products that have already been sold and have been worn out in service; second in supplying new buyers who have never owned the product before. This latter part of the market is pretty well geared to the increase in population. As conditions change and new products gradually supersede the existing product, the market levels off and then begins to decline. The classic example is the buggy whip business which was undoubtedly thriving 100 years ago but has now practically disappeared because of the automobile superseding the horse and buggy.

The foregoing history is quite typical of most industries and the companies that form it.

Sometimes as an industry starts to decline, alert manufacturers recognize trends away from their original field of endeavor and branch out into new fields, but many do not and ultimately become casualties in the business world. This, of course, results in loss to the holders of common stocks and the employees who have made up the organization. This typical industry pattern having a speculative start, then a period of growth, the reaching of the zenith, and ultimate decline, is recognized by investment counsellors and could well be kept in mind by the young engineer selecting his first job.

In general, not very many investors nor very many young engineers can afford to take the chances of the extremely young industries and companies. It is true that our great companies of today were at one time extremely small, and those investors and employees who stayed with them have made fabulous profits or have advanced into high positions through the growth of the company.

The risk of such situations is well illustrated by the dozens of automobile companies which were formed and went bankrupt in the early days of that industry. Out of those early troubled times have grown the great automobile companies of today, some of which rank among our most stable enterprises. Manufacturing automobiles is no longer a particularly speculative line of business; investments and jobs with these companies compare favorably in security with our other leading lines of business.

If a person has the emotional make-up to be happy in very speculative situations, he can consider joining an organization in the very early speculative stage. However, he should be sure that he really has this make-up and can be happy and retain his health under prolonged conditions of extreme uncertainty. A man who is somewhat more conservative, but does not demand a maximum of security, can well consider one of the smaller companies in a growing well-establishing industry.

The company should have a successful record which means the management should have proven itself over a period of years not only to be able to manage well, but also to be progressive, and the company should be in good financial shape. It should have a history of more than average growth which frequently means that in its own industry, its line of products does not completely cover the field. Therefore, the company can grow not only as its industry grows, but also as it adds new products progressively to round out its line. These smaller companies are apt to grow faster percentage-wise than their very large competitors who have been in business so long that their line of products is virtually complete. These large companies are likely to offer a little more security, particularly in the early years of employment, but probably not quite the opportunities for advancement for the average young engineer.

The man who needs still more security to remain happy and whose inclinations are perhaps not very competitive, will probably be better satisfied in one of the largest companies in the most stable industries whose products or services find a market both in good times and bad. As a general rule, these very secure positions do not pay as much salary as the more speculative ones, but there are frequently other forms of compensation such as more favorable insurance, pension or medical treatment plans, company activities, and, above all, peace of mind of the employee.

Now suppose that the young engineer or investor has sized up the situation and has boiled his choice down to a few companies which appear to offer about equal prospects in the future, there is not much more that can be done. The final choice becomes largely a matter of chance and is relatively unimportant as far as the odds are concerned.

It appears, therefore, that the guides of the investment counsellor in choosing attractive common stocks for his client can be useful to the young engineering graduate confronted with a great many opportunities for employment. Both the investor and the young engineer are likely to do well with a growing company in a growing industry, and both will find it impossible to predict much ahead of time their exact rate of progress with extreme accuracy. Both the young engineer and the investor who are willing to take a reasonable amount of risk will find the odds in their favor if they choose an aggressive growing company in a growing industry that is well established in our economic pattern.

UNIFORMS ARE POPULAR

Truck drivers like to wear uniforms, a publication reports as the result of a survey of 618 operators who control 98,022 vehicles. Becoming an important item in fleet operation, uniforms are now worn by drivers of nearly half the fleets surveyed. Providing uniforms as a bonus or award for meritorious service is a growing practice. Main conclusion is drivers like, in this way, to be identified wth their employers, with a substantial number paying some part of the uniform cost. Gray is the favorite color, with green as runner-up.

TO DE-SALT THE SEA?

A pilot plant for de-salting sugar juices through ion exchange membranes with the aid of electric current will be installed on Maui, Hawaiian Island. As applied here, the de-mineralizing involves partial removal of salts such as potassium chloride, thus enabling increased recovery of sugar. The technique further is seen as a possible means of de-salting sea water.

Actual storm ahead as pilot sees it on radar scope. It indicates that, by changing course very slightly, he will find a smooth, safe route.

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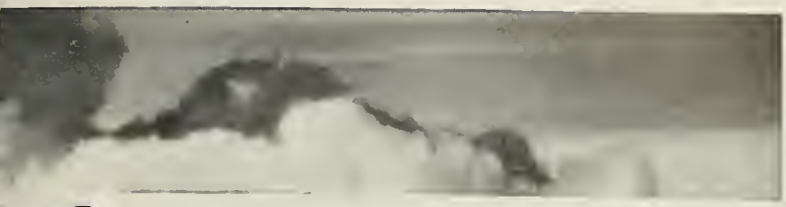

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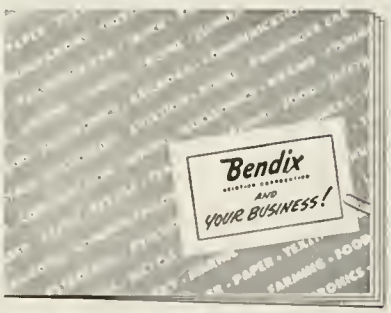

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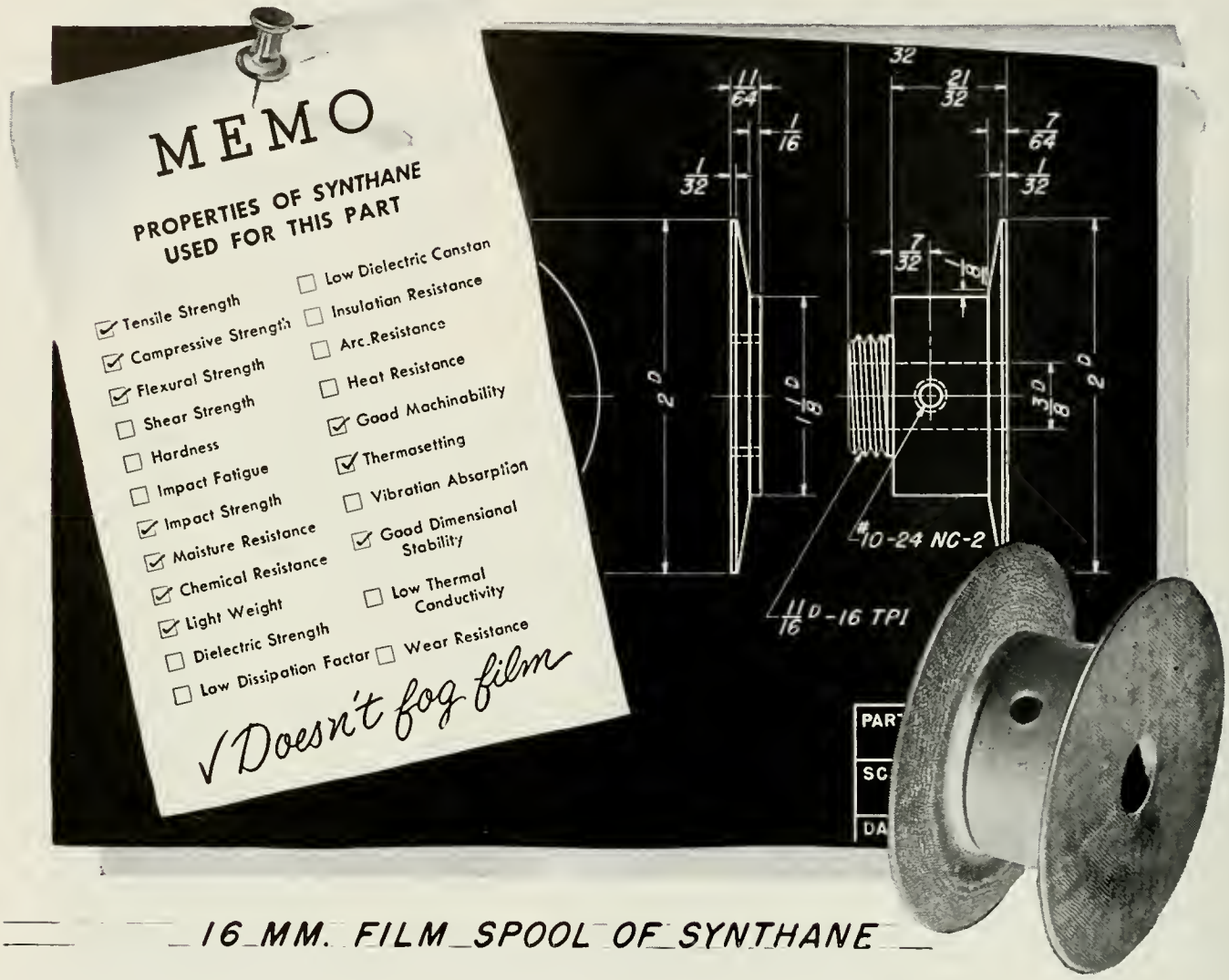

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The film spool we're talking about is one used in the processing of movie film. The material for this spool has to be light in weight, strong and easily machined. Since it is always in contact with film and photo solutions, it must also be chemically-resistant and—most important—not fog the film by chemical contamination.

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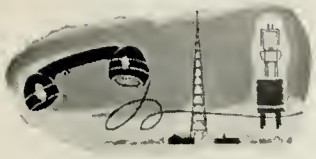
12 of the basic industries in which Bendix products play a vital role



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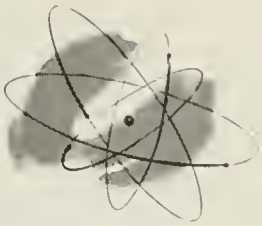

ATOMIC ENERGY

AUTOMOTIVE

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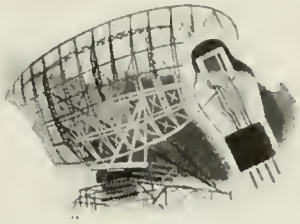
GUIDED MISSILES



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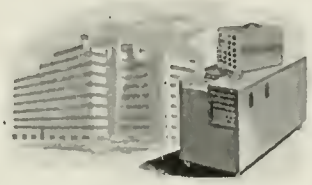

COMPUTERS

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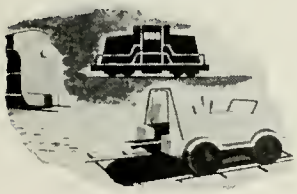

RAILROAD

PETROLEUM

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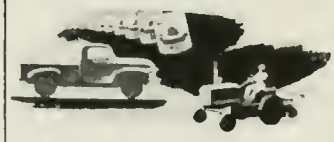

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Fluoridation . . .

HELPFUL or HARMFUL

by Philip Voegtle, San. E. '55

Some fifty years ago in a small Colorado town, a new idea was born which grew to be a major public health problem and which is now in the process of being tossed back and forth between the pros and the cons. To the pros it isn't so much a problem as it is a solution to a problem; and to the cons it is felt detrimental, not only to their own health, but to the health of the public confronted with this new idea. The exchange or arguments between the pros and cons brought about a great deal of research on the subject.

In 1906 Frederick S. McKay, a practicing dentist in Colorado Springs, Colorado, found brown and yellow stains in the enamel of human teeth. He believed these stains were due to the presence of some unknown chemical in the water supply.

This was verified some years later in 1929 when the fluoride ion was accused of being the caustic agent responsible for the mottled enamel.

In the year immediately following, through the work of two men, H. T. Dean and E. Elvove, who were associated with the National Institute of Dental Research, the non injurious amount of fluoride in a domestic water supply was determined to be one part per million, (1 p.p.m.).

With the publication of this fact, people living in areas where the fluoride ion concentration in their water supply was in excess of 1p.p.m. became greatly concerned. Public Health authorities were aroused because there were 631 communities in thirty-eight states which included some one million five-hundred thousand people that were served by water supplies containing naturally occuring fluoride ion in concentrations greater than 1.5 p.p.m.

Research was begun immediately on the problem of removing excessive amounts of fluoride ion from domestic water supplies, but nothing developed except a few makeshift ideas, which were colored by local conditions.

In 1938 a new view on the presence of the fluoride ion in a public water supply was presented by H. T. Dean. His studies revealed that a low concentration of fluoride in a water supply was beneficial in the prevention of tooth decay. He also revealed that the optimal effect was obtained in the range of 1.0 to 1.5 p.p.m.

This was the proverbial spark that set off the explosion dividing the public into the pros and the cons.

After years of preparation, large research projects were set up in such cities as Grand Rapids, Michigan; Newburgh, New York; Sheboygan, Wisconsin; Evanston, Illinois. The water supplies in these cities were treated with a fluoride compound, such as sodium fluoride, while a town nearby where fluoridation was not practiced was used as a control. Some of these cities began to report reductions in tooth decay a few years after fluoridation was begun. Reports stated the success of fluoridation in the experimental cities listed.

Today there are about twenty million people in the United States, and two hundred thousand in Canada that are served fluoridated water. The wide spread usage, however, is no indication that fluoridation is safe and beneficial. Only careful experimentation can prove this. Health authorities have much to say about the results obtained from various experimental cities.

Before 1938 it was conclusively proven that high concentrations of fluorides in a domestic water supply about 2 p.p.m. would cause mottled enamel of the teeth of the users of this water.

In 1938, H. T. Dean demonstrated that there was an inverse ratio between fluoride ion concentration and dental caries. He stated that optimal effect was obtained in the range 1.0 to 1.5 p.p.m. He based this on extensive studies made in twenty-one cities in four states. They were Illinois, Indiana, Ohio, and Colorado. The studies were on 7257 children between the ages of twelve to fourteen. These studies were made on influential variabls such as, environment, diet, public water supply constituents, etc. The final results revealed that the only factors that showed remarkable correlation were the dental caries' rates and fluoride ion concentration.

The prevalence of dental caries was reduced fifty to sixty-five per cent in 1953. Literature published by dental and public health associations is over stocked with further proof of the effectiveness of fluorides in reducing dental decay. There are about eight major research programs in progress today in the United States and Canada which have been active for as many as two to eight years, which have been proving again and again that children who use fluoride-free water have two or more times as many dental caries as children drinking fluoridated water.

The following are some statistics from the eight major research programs.

Brantford, Ontario, Canada: The permanent teeth of six-year-old children felt a reduction in dental decay of fifty-six per cent.

Evanston, Illinois: The number of twelve to fourteen-year-olds whose teeth were unsusceptible to decay increased to seventy-three per cent.

Grand Rapids, Michigan: Six-year-old children presented a sixty-six per cent

A Campus-to-Career Case History

Jim O'Hara (left) works out a problem with a member of his crew

His territory:

TWO CITY BLOCKS

James O'Hara, Stevens Institute of Technology (M.E. '51), is an installation foreman for the New York Telephone Company. His present assignment is two city blocks between 45th and 47th Streets in the middle of Manhattan.

• • •

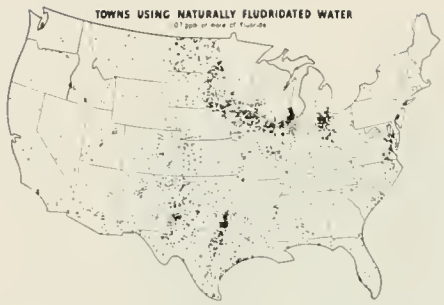
"It doesn't measure very big horizontally," Jim says. "But vertically it makes up a lot of telephone business—7500 telephones to be exact. My eight-man crew does everything from installing a single telephone to working on complete dial intercom systems for some of the nation's biggest businesses.

"I've got to know about each of these jobs that my men do. My training with the telephone company took me through the installation, repair and testing of the various types of telephone equipment and service for which I am responsible. I even had a chance to do a little experimenting of my own and developed a new way of preventing oil seepage on automatic switching equipment. I understand it's being written up for use throughout the Bell System.

"That's what I like about telephone work. Even two city blocks are full of opportunity."

You'll find that most other college men with the telephone company are just as enthusiastic about their jobs. If you'd be interested in a similar opportunity with a Bell System telephone company—or with Sandia Corporation, Western Electric or Bell Telephone Laboratories, see your Placement Officer for full details.

BELL TELEPHONE SYSTEM



reduction in dental decay, and nine-year-old children smiled with a thirty-nine per cent reduction.

Lewistown, Idaho: Six-year-old children again but this time they boasted of a seventy-seven per cent reduction in decay rate in comparison with a forty-seven per cent reduction for their nine-year-old class mates.

Madison, Wisconsin: The primary teeth of the kindergarten class saw a forty-eight per cent reduction in dental rot.

Marshall, Texas: The six-year-old group appears again, but not too happy. Why? They only have a forty-seven per cent reduction in tooth decay.

Newburgh, New York: Worn out but still leading the pack the six-year-olds, carrying a seventy-eight per cent tooth decay reduction. The twelve-year-olds aren't doing badly either with a twenty-six per cent dental decay reduction.

Sheboygan, Wisconsin: The twelve to fourteen-year-olds are happy with a reduction in dental decay of thirty per cent.

While Dean's studies were made on cities having varying amounts of naturally occuring fluoride in the water supply, the eight cities previously mentioned were artificially fluoridated. The hypothesis was that water treated with fluoride would produce the same effects on dental decay as water naturally containing fluoride.

Under the direction of specialized technical personnel and with the supervision of the State Department of Health, annual dental and medical studies were made on the children in the eight experimental cities. By chemical and biological research, by laboratory experimentation, and by epidemiological studies, the hypothesis was proven valid.

According to recent studies, the protection from tooth decay with the use of fluorides in the water supply decreases with the increase of age. This means that at the age of twenty or older, people do not benefit from drinking fluoridated water. The reason for the diminishing rate of dental protection is that people have not been in contact with fluoridated water soon enough. Authorities say that in order to get maximum reduction in tooth decay, people must start drinking fluoridated water at a very early age. The older the people, the less is the reduction of tooth decay.

The effects of fluoridation on the teeth of people between the ages of twenty to forty-four who have been in contact with a naturally occuring fluoride bearing water supply throughout their lifetime is demonstrated by the studies made on the people living in Colorado Springs, Colorado. Clinical dental examinations were given to the people who have been exposed to Colorado Springs' water supply, which contains about 2.5 p.p.m. of fluorides, for a long period of time. These examinations were also given to the people in the same age group living in a nearby town, Boulder, Colorado. The people from Boulder were used as a control because the fluoride ion is nonexistant in Boulder's water supply. The prevalence of fluorosis was constant throughout all age groups in Colorado Springs because of the high concentration of fluorides in their water supply, while the people in Boulder exhibited no evidence of the disease. On the other hand Boulder had sixty per cent higher decayed, missing and filled teeth (D.M.F.) than Colorado Springs for each age group.

Fluoridation of water supplies, just as pasteurization of milk, innoculation against smallpox, and chlorination of water supplies, has been met with organized opposition, although it is probably the most important development in the history of preventive dentistry.

Innoculation against smallpox caused such an uprisal that people who were innoculated were considered a public menace. Innoculations were made secretly. A hospital was burned for fear that it might be turned into an innoculation center. Fluoridation has not met with violence, as has innoculation against smallpox; but it has met with the poison pen. It has been the victim of "name calling" in all the media of communication.

There are many accusations against fluoridation. One of the first was probably that fluoridation was a cause or an accelerator of cancer. This statement probably originated from the article in the Texas Dental Journal of September, 1951. It concerned a mouse cancer experiment which was conducted at the University of Texas. Almost all the mice died of cancer. However, they did not die because of the 0.44 p.p.m. fluorides that they were fed. They died because they were a special strain which was highly susceptible to mammory tumors.

Another interesting fact is that in a few towns in Texas where the fluoride concentration exceeds 3.0 p.p.m., the mortality rate of cancer is eighty-one per hundred-thousand. However, in California where the concentration of fluoride in a water supply is little or none, the mortality rate is one hundred-forty-nine per hundred-thousand.

These Towns Add Fluoride

Another accusation against fluoridation is that it causes unsightly staining of the teeth. This is true but only when the fluorides are in a high concentration, (2 p.p.m. or more). This also depends upon the individual differences. At the concentration recommended by health authorities which is 1 p.p.m. mild cases of dental fluorosis still occur in less than ten per cent of the children using this water. These mild cases of fluorosis can be detected only by the trained eye. A major portion of them will be found only on the back teeth. Many dentists believe that the amount of mottling associated with 1 p.p.m. fluorine in drinking water in most parts of the United States actually enhances the beauty of the teeth.

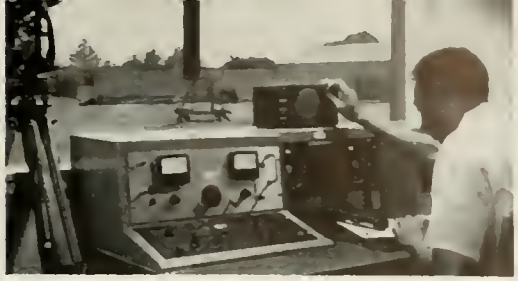
Fluoridated water cannot be accused of being poisonous just because fluorides are used in rat poisons. There are many minerals which we consume today that are deadly at high concentrations. Sodium chloride, ordinary table salt, is just one example of them.

Fluorides in water do not cause bones to become brittle. Detailed studies on 1,458 high school boys in seven cities with varying concentrations of fluorides in the public water supplies showed no effect on bone fracture experience. Where water contains from 1.2 to 3 p.p.m fluorine, x-ray examinations of persons living in the area revealed no evidence of bone fluorosis.

The assertion that inorganic fluorides inhibit essential enzyme functions in humans is a half truth frequently employed by opponents of fluoridation. The critical consideration of this assertion is the fact that the amount or concentration of fluoride is not specified. With a high concentration of fluorides, enzyme functions may be inhibited. There has, however, been no evidence that fluoride ions at a concentration of 1 p.p.m. in water will adversely affect any enzyme of the body.

The State of Illinois, Department of Public Health made studies on the death rates in twenty-two cities in Illinois. They concluded the following:

"Mortality statistics show that there is no significant difference in the general death rates between areas where fluor-



Electronics Research Engineer Irving Aine records radiation antenna patterns on Lockheed's Radar Range. Twenty-two foot plastic lower in background minimizes ground reflections, approximates free space Pattern integrator, high gain amplifier, square root amplifier and logarithmic amplifier shown in picture are of Lockheed design.

Jim Hong, Aerodynamics Division head, discusses results of high speed wind tunnel research on drag of straight and delta wing plan forms with Richard Heppe, Aerodynamics Department head (standing), and Aerodynamicist Ronald Richmond (seated right). In addition to its own tunnel, Lockheed is one of the principal shareholders in the Southern California Cooperative Wind Tunnel. It is now being modified for operation at supersonic Mach numbers.

Research Engineer Russell Lowe measures dynamic strain applied by Lockheed's 500,000 lb. Force Fatigue Machine on test specimen of integrally-stiffened Super Constellation skin. The Fatigue Machine gives Structures Department engineers a significant advantage in simulating effect of flight loads on a structure. Among other Lockheed structures facilities are the only shimmy tower in private industry and largest drop test tower in the nation.

C. H. Fish, design engineer assigned to Lockheed's Icing Research Tunnel, measures impingement limits of ice on C-130 wing section. The tunnel has a temperature range of −40°F. to +150°F. and maximum speed of more than 270 mph. It is the only icing research tunnel in private industry.

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ide is present and those where it is absent. Similarly there is no significant difference in the risk of death from specific diseases such as heart, cancer, nephritis, and diabetes."

Through the research done on the effects of fluorides on yeast fermentation, the Pabst laboratories reported that the concentrations of fluorides up to 5 p.p.m. had little or no effect on yeast fermentation. The concentration of fluorides reached 6,000 p.p.m. before its killing power on yeast cells was comparable to that of a one per cent solution of phenol.

Pabst brewers weren't the only ones to report that fluoridation didn't affect their industry. Nine breweries in Wisconsin alone reported no effects found on the fermentation process when fluoridated water was used.

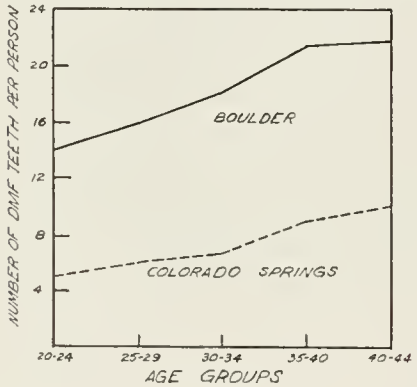
From the laboratories of the American Institute of Baking echoed the same results. This time, however, no effects were obtained until the concentration of fluorides reached 10 p.p.m.

The American Bottlers of Carbonated Beverages concluded that no effects resulted from using fluoridated water from the fact that several companies were operating in cities where fluoridation was practiced with no ill effects.

The canners primary concern was the effects of fluoridated water on flavor, color, or texture of their product and the corrosive effect on the can. There were no reports of ill effects on the food process. Therefore, it is safe to assume that there were none.

The only industrial complaint of fluoridated water came from Charlotte, North Carolina, where an ice manufacturing plant reported a fifty per cent increase in the cracking of ice blocks when 1.0 p.p.m. fluoride was added to the water supply. This was remedied by adding twenty p.p.m. of ammonium chloride to the water at the ice plant. No other such happening has been reported, and it is believed that the excessive cracking was due to the low alkalinity of the water supply.

An interesting effect was that of fluoridated water on plants. Studies were made in 1953 at the University of Illinois fluoricultural greenhouses on seven



different types of flowers—Calhopsis, Chrysanthemum, Cynoglossum, Marigold, Marvel of Peru, Nicotina, and Zinnia. They were watered for two months with fluoridated water varying in concentration from 0.0 to 100.0 p.p.m. Up to 50 p.p.m. the difference in the weight of the flowers was not significantly changed, but in height the Marigolds when water with 1 p.p.m. and 5 p.p.m. were about 1.3 inches taller than those watered with tap water, which were used as a control.

Fluoridation is not mass medication. Medication in the pure sense of the word means to cure or treat an existing disease or condition. Fluoridation does not cure tooth decay; it prevents it. Fluorides are natural consitutients of water, as they are in teeth and bones. Fluorides are added to increase their concentration in the water to a more beneficial range. The addition of fluorides to the water is like enriching bread with vitamins to make the bread more healthful. It is like adding table salt or other materials to food to make it more healthful and palatable. Certainly the enrichment of bread with vitamins and the addition of table salt to food are not considered mass medfication. Why then should the enrichment of water with fluorides be considered thus?

Fluoridation does not constitute socialized medicine. Fluoridation is not medication or any form of medicine. Fluoridation is no different from chlorination or any other measures used to prevent disease. Fluoridation is a preventive measure not a cure.

Fluoridation is not a restriction of religious freedom. This is based on the assumption that fluoridation is medicated water. Even if it were, the First Amendment to the Constitution of the United States states that the right of a special group to engage in the practice of its religion must not unreasonably interfere with the right of a community as a whole to enjoy what it determines is beneficial for its well being.

1,000 p.p.m. sodium fluoride is necessary to cause acute diseases. The amount of sodium fluoride necessary to produce this degree of concentration would be eight thousand pounds per one million gallons. According to the program set up by public health authorities, such an amount of fluoride ion could not enter the water system unless gross negligence occured. As for sabotage occuring, why should a saboteur depend on tons of sodium fluoride to do the job when only one ounce of other poisons, as botulinus toxin, in a reservoir would perform a more complete job.

Fluoridation will not present many difficult engineering problems. The mechanics of fluoridation are no more involved than those of water purification. The machinery and equipment commonly used in water plants are easily adapted. On the whole fluoridation is practical from an engineering standpoint.

Climate is an important factor which must be considered in fluoridating a public water supply. When the mean annual temperature is approximately 50°F., the fluoride ion concentration greater than 1.6 p.p.m. will produce objectionable fluorosis. Whereas, when the mean annual temperature is approximately 70°F., the fluoride ion concentration greater than 0.8 p.p.m. will be sufficient to produce the same results. This is probably because people living in warmer areas tend to drink more water and, consequently, consume a greater quantity of fluoride ions.

Temperature is not the only climatic factor to be considered. However, studies made indicate that relative humidity and mean annual temperature combined provide adequate indexes for determining the fluoride ion concentration to be added. For a more complete study of the optimal amount to be added, the evaporation point, which depends upon wind movement and barometric pressure, should also be taken into account.

Fluoridation is said to be a preventative of tooth decay; but what is tooth decay and when did it originate? Tooth decay probably originated with Adam and Eve in the beginning of mankind. Of course, there are no records of this medical development; but there are records of tooth decay occuring thirty-seven centuries before Christ.

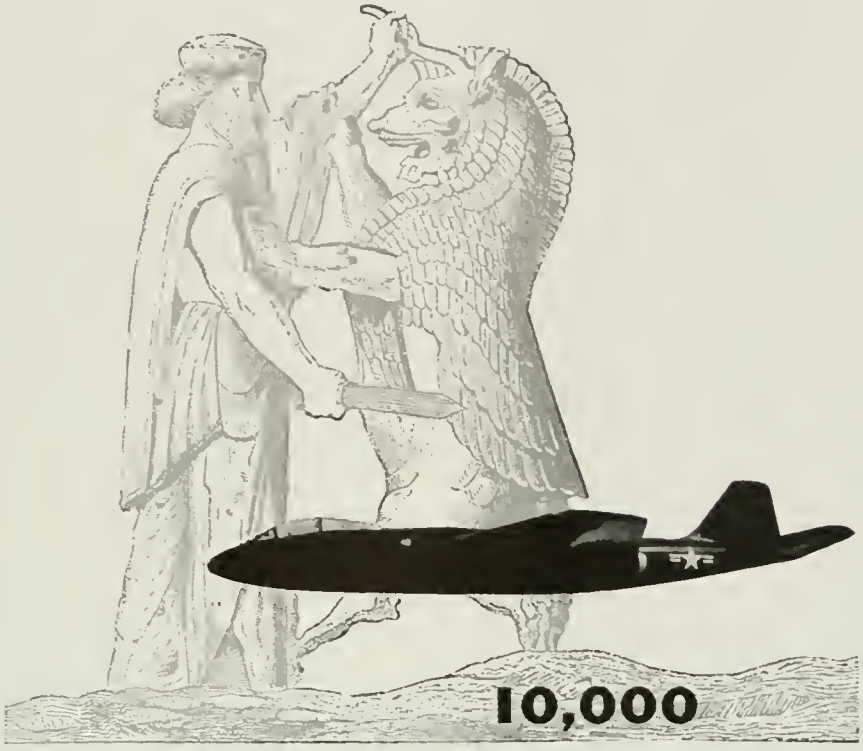
After fifty years of research supported with recent studies, the American Dental Association gives this definition of tooth decay:

> "Dental caries are caused by acids resulting from the action of micro-organisms on carbohydrates, are characterized by a decalcification of the inorganic portion and are accompanied or followed by a disintegration of the organic substance of the tooth."

The micro-organism which produces the acid that causes tooth decay is *Lactobacillus acidophilus*. Therefore, to reduce tooth decay we must either reduce the production of this acid or decrease the solubility of the tooth enamel in the acid. The fluoride ion accomplishes both.

During the experiments on Newburgh, New York, counts were made on the number of bacteria per cubic centimeter in the saliva of children. Using two criterion, a negative count (under 100 bacteria per c.c.) and a high count (over 20,000 bacteria per c.c.), samples were taken prior to fluoridation and then annually afterwards. At the end of one year the negative count went from 11.9% to 13.4%, and the high count dropped from 63.5% to 55.2%. After two years the negative count was twenty per cent and the high count was forty-seven per cent.

A quantitative analysis made on sound



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Vulcanizing Chamber

Application of Insulation and Jacket Compounds

Unvulcanized mill-mixed rubber insulating compounds may be applied to conductors and cables by either the strip insulating or extrusion processes. There are two modifications of the extrusion process depending on the method used for vulcanizing the rubber after its application to the conductor, namely, the pan cure process and the continuous cure process. Laytex insulating compounds are applied to conductors by the repeated or continuous dipping process.

STRIP INSULATION—In the strip insulating process, the compound is calendered to the desired thickness and backed with talc or a paper, cloth, or metallic tape to prevent adhesion of successive layers during processing. The rubber sheet and tape are cut into strips of a width slightly greater than the circumference of the conductor to be insulated, and each strip is taken up in a separate roll. A strip and the conductor are then fed into the circular opening formed by aligning semi-circular grooves in the outer surfaces of two rolls whose circumferences contact. The rolls are driven in opposite directions, thus folding the strip longitudinally about the conductor and pressing its edges in firm contact. The tape is left on the wire during vulcanization. If made of a suitable weatherproof material it may be permanent, but if made of metal it must be removed after vulcanization. The strip-insulated, taped conductor is generally taken up on reels for vulcanization.

EXTRUSION—In the extrusion process the rubber insulating compound is applied to the conductor in an extrusion machine similar to the strainer described under the preparation of rubber compounds. The head of the machine supports a guide and die and provides a passage for the compound from the screw through the guide and die assembly to its point of application to the conductor. The guide holds the conductor centered with the respect to the die. The die contains an opening approximately equal to the diameter of the insulation and

US RUBBER

UNITED STATES

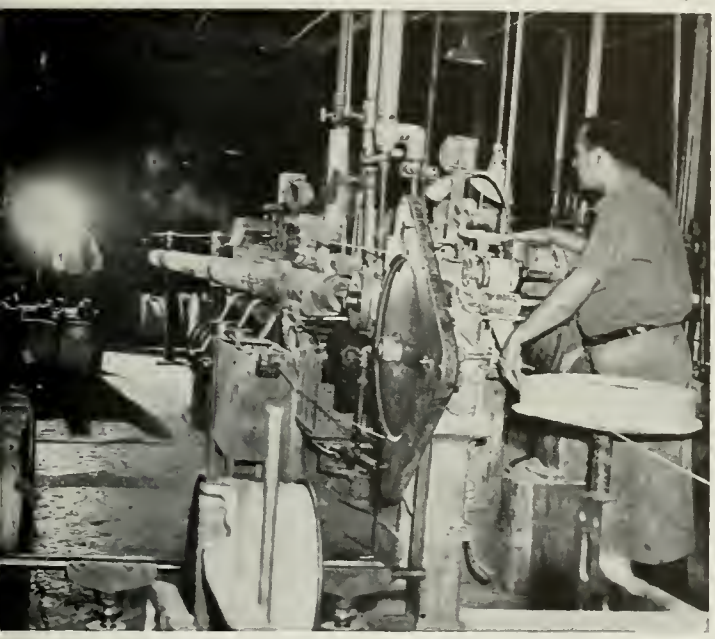
ELECTRICAL WIRE & CABLE DEPARTMENT

be obtained. The guide and die are so located that there is an annular space between them through which the rubber compound reaches the conductor.

The driven screw of the extruder forces the unvulcanized compound through the guide and die assembly around the conductor. The equipment is provided with a driven take-up capstan which pulls the conductor through the machine and a revolving pan in which the rubber-covered conductor is laid. Successive layers of the covered conductor are separated with finely divided talc to prevent adhesion of successive layers during vulcanization. A tape may be applied over the insulation on larger conductors before vulcanization to assist in maintaining concentricity of the insulation with the conductor.

Rubber or rubber-like jackets are applied to rubber insulated single conductor cables or over the assembly of multiple conductor insulated cables by the extrusion process. Such jacketed cables are

Continuous Cure Process



taken up in pans of talc as described for insulated conductors. A continuous lead sheath is applied over the unvulcanized jacket compound and the lead covered cable taken up on reels for vulcanization.

VULCANIZATION—The pans or reels containing the unvulcanized rubber insulated conductor or jacketed cable are then placed in a vulcanizing chamber where they are subjected to steam at the required pressure and for the required time to suitably vulcanize the rubber. The pressure is then slowly reduced to atmospheric pressure and the pans or reels removed from the vulcanizer and allowed to cool. The insulated conductors are then removed from the pans. This handling of the insulated conductor in pans through the extrusion and vulcanizing processes accounts for the term "pan cure process". Non-permanent tapes are then removed from strip insulated conductors and the lead tube from the jacketed cables.

CONTINUOUS CURE PROCESS—The continuous cure process employs a standard extrusion machine similar to that used in the pan cure process, but equipped with a modified head to which a vulcanizing tube is attached and provided with means for automatically controlling the temperature of the cylinder, screw and head.

The head differs from that used in the pan cure process in that the guide and die are mechanically centered with respect to each other and the compound space surrounding them is smaller. Centering of the guide and die is obtained by the use of accurately machined holders which fit snugly into perfectly centered openings in the head. This provides centering of the insulation or jacket compound at all times without adjustment by the operator. The compound space in the head is reduced to prevent premature vulcanizing of the highly accelerated compounds used in this process. Automatic control of the temperature of the cylinder, screw and head is required for successful extrusion of such compounds.

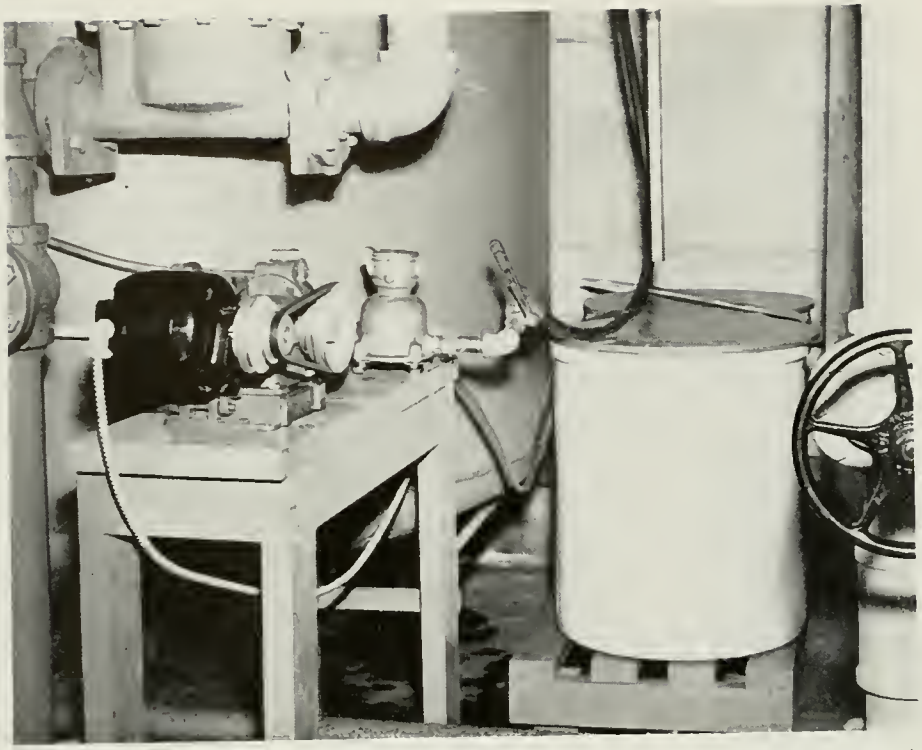
The vulcanizer attached to the tubing machine consists of a 2-inch steel pipe jacketed with a properly insulated 3-inch pipe and is approximately 125 feet in length. Vulcanizing steam pressure is maintained in the annular space between the vulcanizing tube and jacket to insure immediate attainment of the vulcanizing temperature when steam is admitted to the vulcanizer tube. The vulcanizer is provided with a splice box adjacent to the tubing machine and a suitable seal at the opposite end.

The driven screw of the extruder forces the unvulcanized compound through the guide and die assembly around the conductor or cable and directly into vulcanizer containing steam at 225 pound pressure. Highly accelerated compounds capable of vulcanizing in a few seconds are used so that the process can be operated at economical speeds. The speed of travel of a covered conductor or cable and the acceleration of the compound are so adjusted that the insulation or jacket is properly vulcanized while traveling the length of the vulcanizer. The vulcanized insulated conductor or jacketed cable is taken up on a suitable reel directly from the vulcanizer. The term "Continuous cure process" follows from the fact that the insulation or jacket is applied and vulcanized in one operation.

APPLICATION OF LATEX—The application of latex insulation consists of passing the coated conductor beneath the surface of a latex compound from which it is brought vertically into a suitable drying chamber. It continues to travel vertically in the chamber until the film is dry. It is then returned for the application of a second layer of compound. This alternate dipping and drying is continued until a wall of the required thickness is applied and dried. The amount of insulation deposited per application depends on the conductor size, the viscosity and temperature of the latex compound and the speed to which the conductor travels.

The conductor, covered with the required thickness of dried unvulcanized latex compound then passes through a vulcanizing chamber where the insulation is vulcanized and continues through a talc applicator to the take-up reel. This process is thus a continuous one in that the application of the insulation to the conductor and its vulcanization are accomplished in one operation.

Application of Latex



Equipment necessary to fluoridate a public water supply using a liquid feeder system, propartioners included. (Photo by State Department of Public Health)

teeth and carious teeth from the same mouth by Armstrong and Brekhus showed that the sound teeth contained 110 p.p.m. of fluorine while carious teeth contained only 69 p.p.m. of fluorine. As the other constituents remained approximately equal, it was proven, indirectly, that fluorine decreases the solubility of teeth.

Even this conclusive evidence reveals that the fluoride ion is still not the ideal inhibitor. Concentrations too toxic are necessary to inhibit the production of all destructive acids. However, if the amount of acids is reduced ten per cent, this will still ensure a reduction in decay rates of from sixty to ninety per cent.

The cost of fluoridation varies depending upon the amount and type of fluoride used. It averages yearly about nine cents per person. The cost of an average filling will provide a person with enough fluoride ion for thirty years. Fluoridation will reduce future dental bills for extractions, fillings and other dental work. More than nine hundred communities in the United States have demonstrated that fluoridation is inexpensive.

Fluoridation has been endorsed by important national associations as the American Dental Association, the American Water Works Association, the American Public Health Association, the American Medical Association, and the American Association of Public Health Dentists.

The history of fluoridation began as early as 1906 when Frederick S. McKay, a practicing dentist in Colorado Springs, Colorado, accused a caustic agent in the drinking water, later found to be the fluoride ion, for the mottled teeth of his patients. Later men like H. T. Dean and E. Elvove did research on the fluoride ion and found that 1.0 to 1.5 p.p.m. fluorides was beneficial in the reduction of tooth decay, but that a great concentration of the fluorides was responsible for the staining of teeth. Much research is and was done on fluoridation.

Many claims were made against fluoridation. It was claimed poisonous, too expensive, the cause of disease, and detrimental to industry. Research has proven each claim wrong in its turn. Research has proven that fluorides added to the water improve the appearance of teeth and reduce dental decay in children about forty-five per cent. It has proven that fluoride does not change the physical character of water—taste, color, odor, or hardness; that fluorides do not produce ill effects in industrial plants; and that the yearly cost of fluoridating water per person is only 9c per year.

On the basis of the evidence revealed in the preceding material, it is safe to conclude that fluoridation is beneficial and should be practiced universally, except, of course, in places where the fluoride ion is already in sufficient amount. Truly to delay the fluoridation of public water means to deprive children of the proper health benefits. This is especially true since these benefits can be obtained at very little cost.

Miss March

Our Technocutie this month is Anne Barretta, a twenty-year old miss from Meadville, Pennsylvania. Here on campus she is employed as a stenographer in the Electrical Engineering Building. Anne's hobby is art and at present time she is taking an art course at the University. For those of you whose hobby is collecting statistics, the following information might be up your line. Anne is 5'2" tall, weighs 123 pounds, and tapes 34-24-34. She has brown eyes and brown hair, and for those who are interested she isn't attached. By the way, she mentioned that she is overrun with work at the EE Building and would appreciate any help volunteered.

DAVID L. KOMYATHY
Photographer

She: What's the difference between dancing and marching?

He: I don't know."

She: I didn't think you did. Let's sit down.

* * *

Pledge (at dinner table): "Must I eat this egg?"

Brother: "Yer darn right!"

Silence.

Pledge: "The beak, too?"

* * *

Lawyer: "What if a man IS on his hands and knees in the middle of the road? That doesn't prove he's drunk."

Policeman: "No, it doesn't. But this one was trying to roll up the white line."

* * *

Hudson House Supervisor—How do you like this room as a whole?

Incoming Student—As a hole, it's fine; as a room, not so good."

* * *

Once a young college female wrote the editor of a correspondence column, "I am only 19 and I stayed out till two the other night. My mother objects. Did I do wrong?"

The answer published in the paper the next day: "Try to remember."

Techno-cutie of the month . . .

LUCKILY, EUCLID WAS A GREEK

From the drawing boards at New Departure have come many of the world's ball bearing advancements. Such leadership is one reason why engineers everywhere specify New Departure ball bearings.

If Euclid had lived 2,300 years longer, he would have made Tau Bete. That's why he's pictured here wearing the Tau Beta Pi key.

After all, every engineer owes Euclid a big debt. At New Departure, for example, we work with circles and spheres. Without Euclid, we might still be getting started.

As it is, though, New Departure has gone further with spheres and circles in relation to moving parts than anyone else in the world. From this knowledge have come such advances as the Sealed-for-Life and the double-row angular-contact ball bearings. And it's advances like these that make New Departure the world leader in ball bearings.

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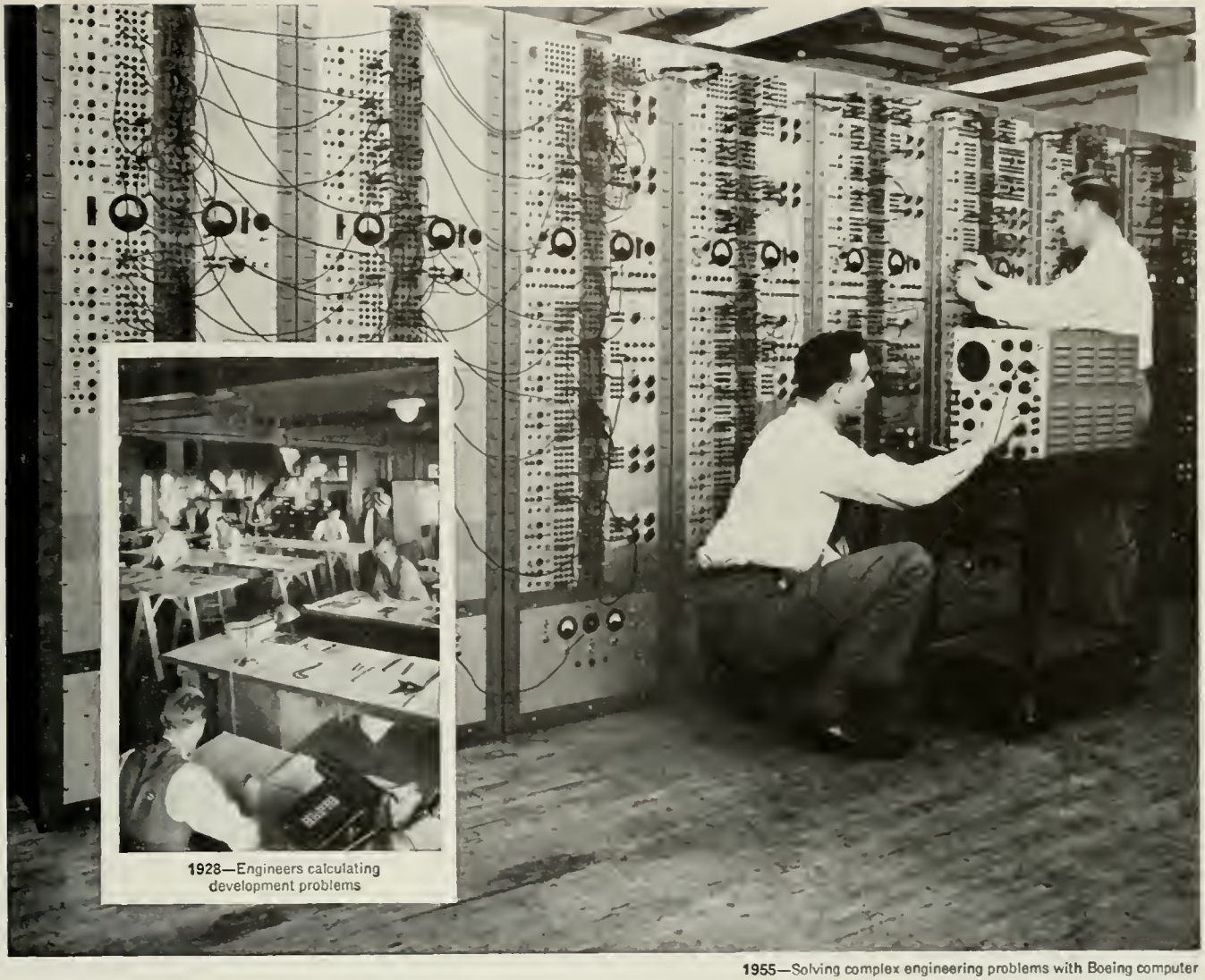
BALL BEARINGS

NOTHING ROLLS LIKE A BALL



1928—Engineers calculating development problems

1955—Solving complex engineering problems with Boeing computer

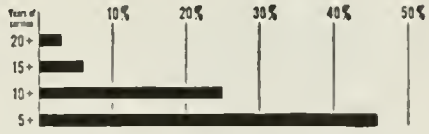
The best research facilities are behind Boeing engineers

The Boeing-designed electronic computers shown above solve in seconds problems that once required weeks—typical of the advanced "tools" that help Boeing engineers stay at the head of their field.

Boeing engineers enjoy such other advantages as the world's fastest, most versatile privately owned wind tunnel, and the new Flight Test Center—the largest installation of its kind in the country. This new Boeing Center includes the latest electronic data reduction equipment, instrumentation laboratories, and a chamber that simulates altitudes up to 100,000 feet. Structural and metallurgical research at Boeing deals with the heat and strain problems of supersonic flight. Boeing electrical and electronics laboratories are engaged in the development of automatic control systems for both manned and pilotless aircraft. Other facilities include hydraulic, mechanical, radiation, acoustics, and rocket and ramjet power laboratories.

Out of this exceptional research background engineers have developed such trend-setting aircraft as America's first jet transport, and the jet age's outstanding bombers, the B-47 and B-52. Research means growth—and career progress. Today Boeing employs more engineers than even at the peak of World War II. As the chart shows, 46% of them have been here 5 or more years; 25% for 10, and 6% for 15.

Boeing promotes from within and holds regular merit reviews to assure individual recognition. Engineers are



encouraged to take graduate studies while working and are reimbursed for all tuition expense.

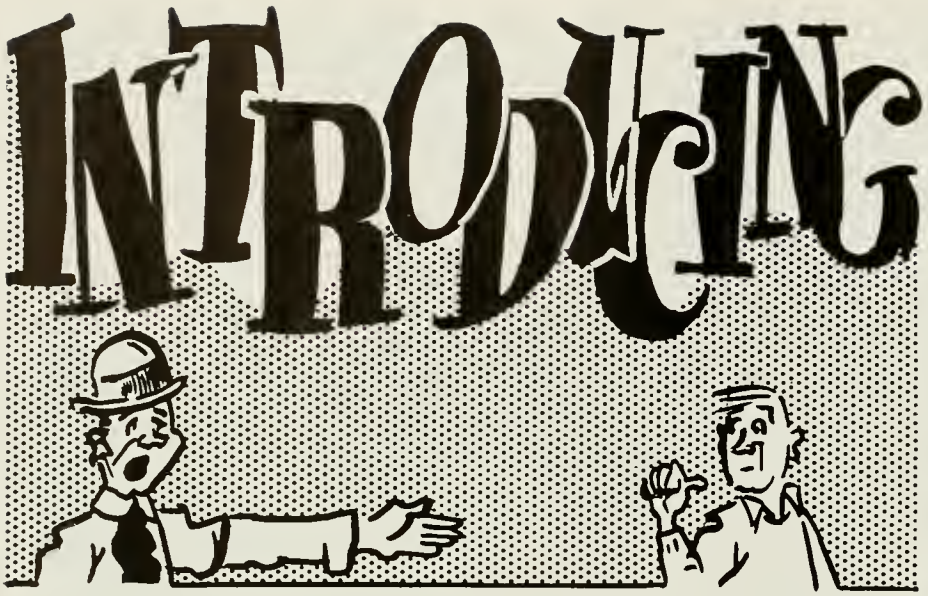
There are openings at Boeing for virtually all types of engineers—electrical, civil, mechanical, aeronautical and related fields, as well as for applied physicists and mathematicians with advanced degrees.

For further Boeing career information consult your Placement Office, or write:

JOHN C. SANDERS, Staff Engineer — Personnel
Boeing Airplane Company, Seattle 14, Wash.

BOEING

SEATTLE, WASHINGTON WICHITA, KANSAS



by Donna Rudig, Jim Piechacki, and Millard Darnall

KEITH A. YARBOROUGH

One of the best-known faces down around the Boneyard these days is none other than Keith Yarborough, president of Engineering Council, Mu San, and Chi Epsilon. He is from La Grange, where he debeated on his high school team.

A staunch supporter of Engineering activities, Keith has worked on Engineering Open House each year and helped with St. Pat's Ball. As if these

KEITH A. YARBOROUGH

activities and his presiding duties are not enough, he also belongs to Phi Eta Sigma, Phi Kappa Phi, Pi Mu Epsilon, and Tau Beta Pi, plus winning a scholarship bauble last year. He firmly believes that the purpose of Engineering Open House is threefold: (1) to demonstrate to the people of this state the potential of training and research which this university offers, not only in the line of defense but also in that important project—raising the standard of living, (2) to help potential engineers become interested in the various fields of engineering and to familiarize them with the type and quality of training which can be obtained; (3) to let industrialists and producers know that our engineers are adept in the art of working with people, supplementing their technical knowledge.

Keith is also an enthusiast of traveling, especially that which includes fishing and camping. Because of his interest in historical reading he would particularly like to visit Germany, France, and England.

After graduation Keith intends to continue here at Illinois until completion of his M. S.; he is already taking some graduate courses. Eventually he would like to teach Sanitary Engineering or related courses to college students.

LARRY KIEFLING

If you ever walk into the TECHNOGRAPH office one afternoon and find someone wading through the files, you can bet your best slide rule that it's Larry Kiefling at his job of circulation manager again. This Cowden, Illinois, (pop. 600) lad not only handles circulation, but also turns out a mighty fine news article each month. And almost as a sideline, he maintains a 4.4 average to boot!

Larry made Phi Eta Sigma, the freshman honorary, in his first year at the University of Illinois, and he humbly tells us that there are other invitations to honorary fraternities resting on his desk at home.

When asked what particular aspect of engineering interests him, Larry leaves the impression that he's interested in them all. His Tech articles prove this,

LARRY KIEFLING

for he has covered subjects from diffraction gratings to Super Sabres. Then, too, if you're in the mood for a discussion about the relative merits of rural and urban living, Larry's the man to see.

And what's the word around the Tech office when the deadline ogre rears its urgly head? Why, "Copy from Kiefling," of course.

HOWARD L. WAEELAND

Howard Wakeland graduated with a B.S. in Agricultural Engineering in 1950 and with a M.S. in the same field in 195. Howard worked on the Illinois State Water Survey for a year after he received his B.S. degree, and the past three years he has been an instructor in the Agricultural Engineering Department. Howard is now teaching half-time and working half-time in the Engineering college office as an assistant associate dean.

Mr. Wakeland's hobbies all seem to have some connection with sports. He referees high school football and basketball in the Champaign area. Baseball and golf are also his hobbies.

Mr. Wakeland remarked that he is surprised at the number of freshmen that he has already met in his officiating of high school sports. He said he has recognized many men who he had put out of a basketball game with five personal fouls. *(Continued on Page 60)*

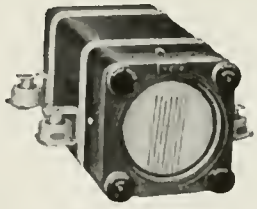
New RCA Radar "Weather Eye" Sees Through Storms

In our time, Man has won round after round in a contest against the elements that started thousands of years ago.

The most recent scientific victory is something new in Radar—an electronic "Weather Eye" developed by RCA.

In airplanes, this supersensitive instrument peers miles ahead. It gives advance warning of weather disturbances. The signals on its radar screen point the way to a safe course *around* storm areas, or even *through* them.

The leadership in electronic research that made the "Weather Eye" possible is inherent in all RCA products and services. And at the David Sarnoff Research Center of RCA, Princeton, N. J., scientists are continually at work to extend the frontiers of "Electronics for Living."



New RCA Weather Mapping Radar weighs under 125 pounds, takes little space in a plane.

For information regarding design and development engineering positions on such projects as "Weather Eye" Radar and military electronic equipment—write to Mr. Robert Haklisch, Manager College Relations, Radio Corporation of America, Camden 2, N. J.

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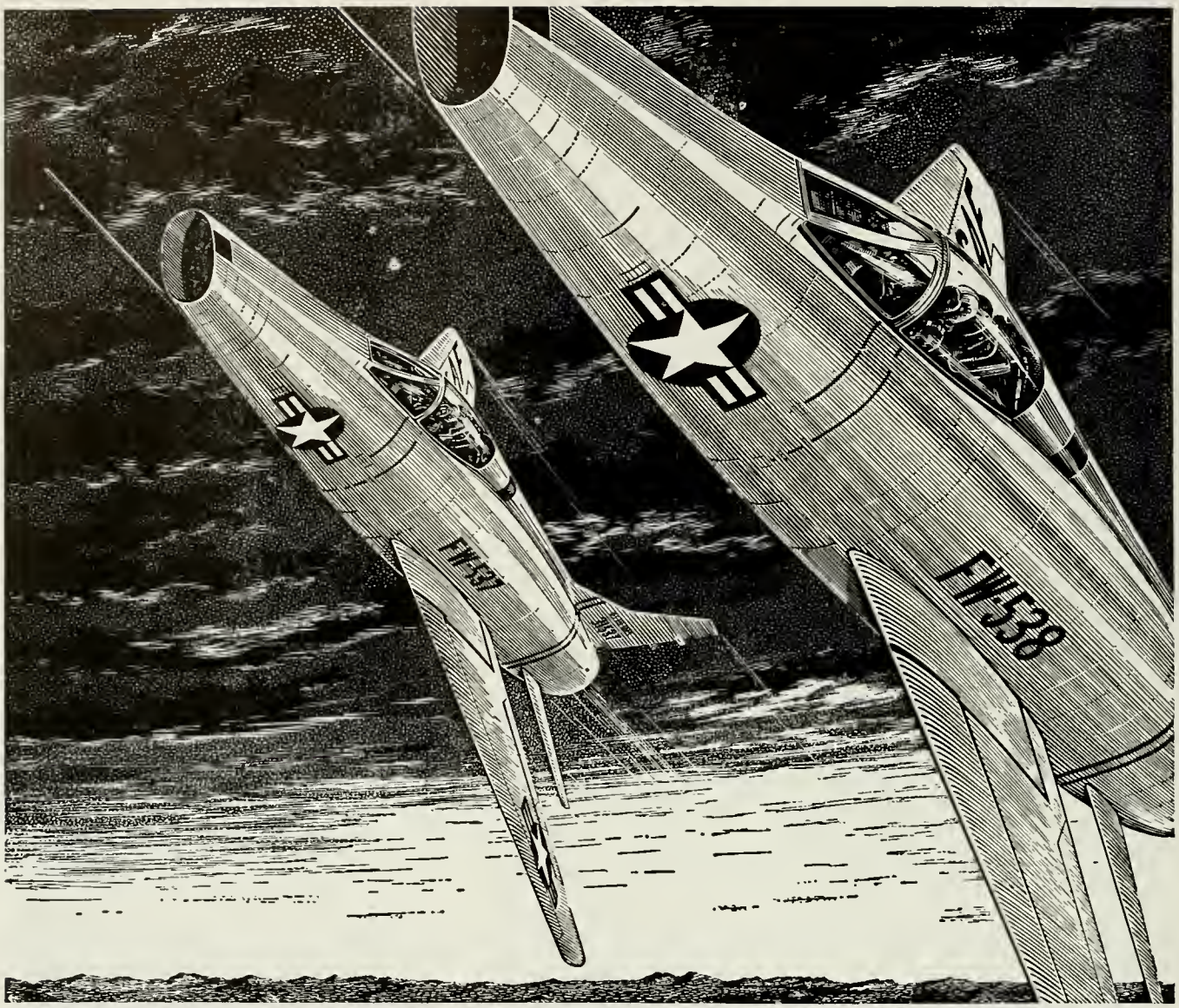

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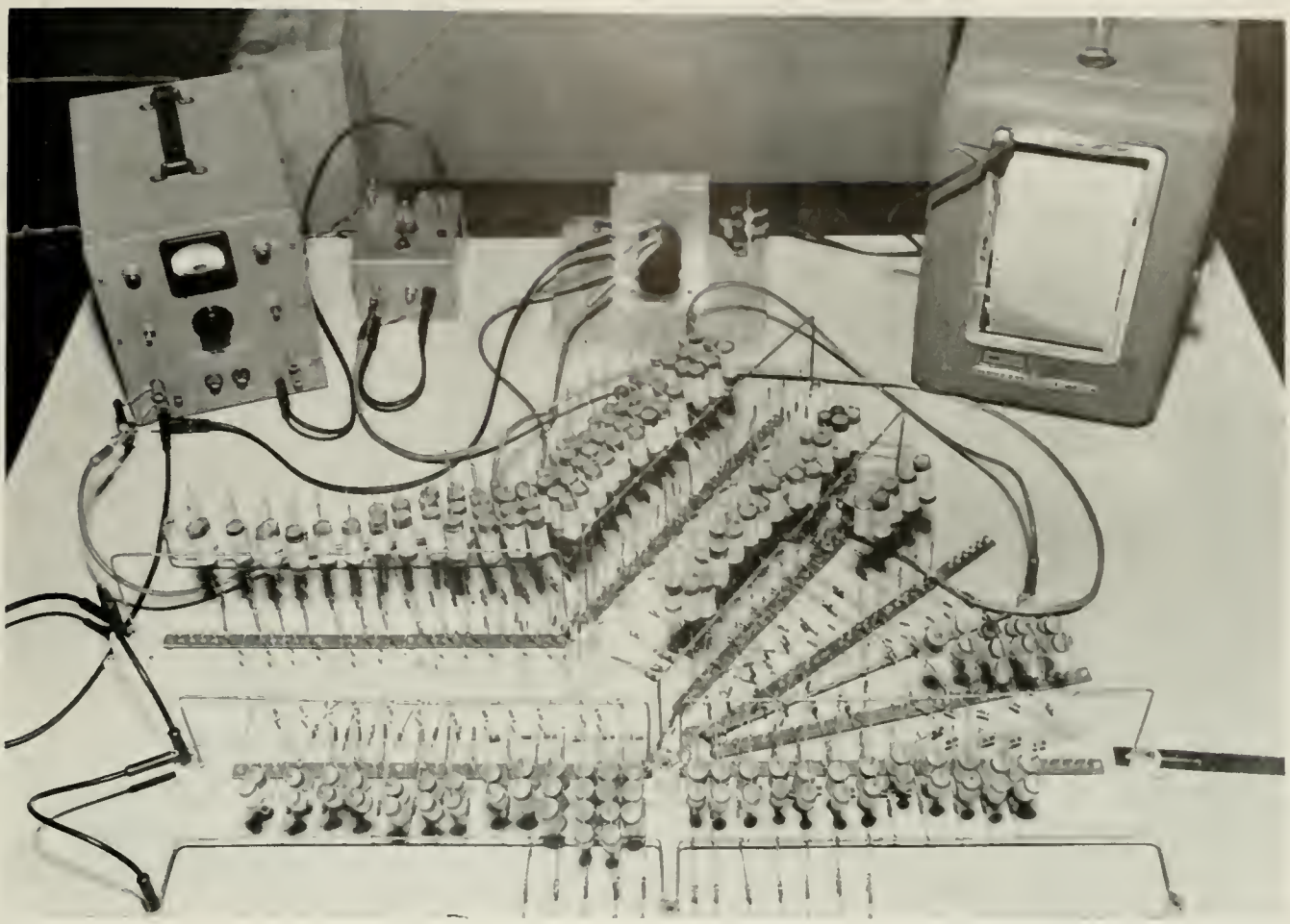
NORTH AMERICAN AVIATION, INC.



This analogue computer, a pioneer in this age of "thinking machines", was developed by Standard Oil scientists.

New Electronic "Engineer" Solves Tough Refinery Problem

THE MEN who design modern oil refineries need specific information about temperature distributions in different parts of pressure vessels. Such information, essential to safety and efficient operation, is often extremely difficult to obtain by conventional mathematical methods.

Scientists at Standard Oil's Whiting laboratories recently developed and built an electrical analogue capable of simulating specific conditions within a refinery unit still in the design stage. Using this device, they could determine in advance the temperature distribution in the joint between two pressure vessels having a common head. Thus they were able to duplicate in 20 seconds the heat stress picture within the unit during an 8 hour start-up to shut-down period.

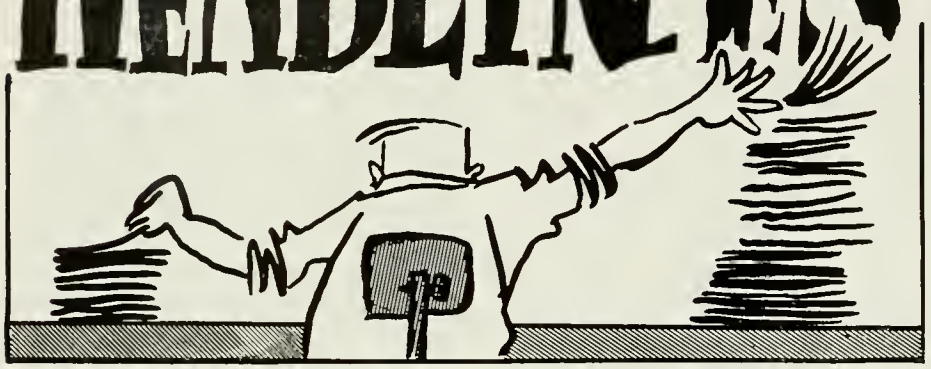
Creative scientific thinking made possible this constructive achievement by engineers who have chosen to build their careers at Standard Oil.

Standard Oil Company

910 South Michigan Avenue, Chicago 80, Illinois

STANDARD

SKIMMING INDUSTRIAL HEADLINES



by Larry Kiefling, M. E. '56

Fighter Planes Launched

Piloted jet fighter planes are being launched like guided missiles. Using platforms mounted on trucks to explore the possibility of eliminating runways under certain combat conditions the world's first flights of conventional jet fighters without preliminary take-off runs were hailed as ushering in a new era in aerial warfare.

The launching technique was developed by the Air Research and Development Command of the Air Force and the Glenn L. Martin Company. Employing the same principles and equipment used in launching the Martin Matador and Air Force guided missiles, engineers conducted experiments at Edwards Air Force Base, California. Warweary F-84-G Thunder Jets made the historic flights. Standard production Republic Thunder Jets were modified so booster bottles could be attached beneath their tails. The boosters are the same type and size used on the Matador.

Highly mobile trucks with arms, raised the fighter planes to the launching angle and became the world's smallest airports with the plane's turbo jet engine running at full speed. The thrust of the booster bottles kicked the fighters off so swiftly they were immediately airborne. Martin test pilot Bob Turner said the shock of the unconventional take-off was less than what pilots experience during catapult take-off. The planes were always under the pilot's control and a peak acceleration of four "G's" was reached (one "G" is pull of gravity).

Because launchers are so mobile, they can be moved quickly from one place to another. No permanent installations are necessary—no runways, hangars or other construction.

The developers of the launching system envisioned jets operating close to the front line and preventing minimum targets to the enemy. Conventional landings could be made at forward bases and the aircraft immediately dispersed for maximum protection while readying for the next flight.

"This is a new concept of fighter plane dispersal," on Air Force spokesman commented. "It is especially important in the age of the atomic warfare when a single enemy plane might wipe out a single airport and make its entire area indefinitely untenable."

Zero length launching, while not a new development, has been proven by nearly 200 Matador launchings. The Thunder Jets, considerably larger than the guided missiles, have demonstrated that the technique is practical and adaptable for fighters.

Windshield Research

Safer, icre-free aircraft windshields now are being built as the result of a 4½-year research program concluded recently at Armour Research Foundation of Illinois Institute of Technology, Chicago. The project was sponsored by the Wright Air Development center, Dayton, Ohio, so designers could specify failure-proof windshields that would never shatter, but only crack under the worst military and climatic conditions.

Two of several important developments resulting from the project were released by William T. Savage, supervisor of the materials engineering section, and Joseph S. Islinger, associate research engineer, both at the Foundation:

1. A system was developed for measuring over-all optical quality of windshields as they were affected by imposed laboratory conditions. The system employes a rectifying plate that corrects for distortion directly, thus alleviating the necessity of mathematical corrective calculation after test photographs are made.

2. A windshield mounting employing a synthetic fiber cloth was developed. The fiber, replacing aluminum in some applications, improved stress isolation of the windshield, necessary in conditions of intense airframe distortion and vibration.

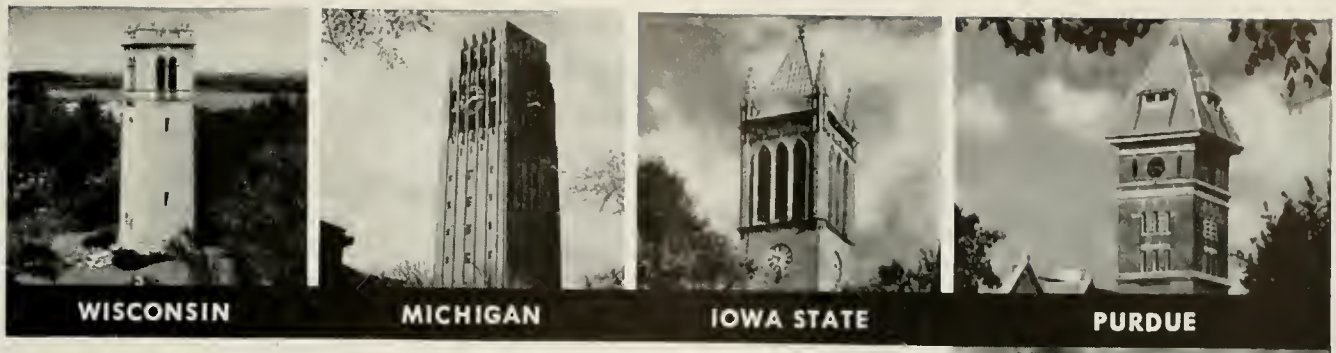
Most of the research was undertaken to find a pressure-proof, distortion-free, anti-icing windshield that would be satisfactory for global operation, Savage and Islinger said. One experiment sought to keep the temperature on the outer surface of the windshield at about 40 degrees F. to prevent ice from forming.

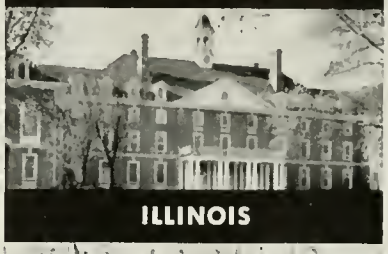
In others, scientists had to consider air friction, evaporation, thermostatic arrangements for controlling the heat, stresses, and other complex factors.

Safety also entered the picture in the case of pressurized cabins or cockpits. In order to establish design limits for concepts determined throughout the program, engineers simulated flight conditions, putting their windshields through vigorous tests. Experimental models were subjected to low temperatures, thermal shocks such as might be encountered in flying into a super-cooled cloud, stresses caused by the heat input in deicing, more stresses induced by cabin pressurization—still others due to airframe distortion, speed, or air gusts.

To perform many of the tests, special heat transfer and stress equipment had to be devised. Often, water was used as the heat transfer medium instead of air because it is easier to control and regulate. The stress analysis studies were similar to those used by industry to achieve stronger, lighter machine parts.

In one test, alcohol, cooled to 90 de-





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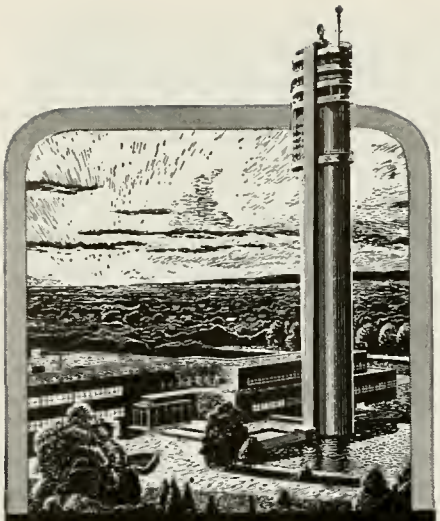

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grees below zero F., passes across one side of a pane of glass. Heat, supplied electrically, is stepped up slowly on the other side until the temperature rises to about 500 degrees F. and the glass cracks—like a milk bottle breaking when filled with boiling water.

Although windshields never may meet these extreme temperatures in use, information on temperature differences and resultant failure is valuable to designers and engineers. Benefits of the windshield research are expected to be made available to civilians early next year by the Wright Air Development center.

Overload Protector Coupling

A new overload protective coupling, whose use safeguards against costly breakdowns of machines and machinery with loss of production time and expensive material damage, is announced by the manufacturer. This device is used between any drive shaft and a

This device limits the load which can be transmitted to a shaft.

driven shaft, giving positive low cost instant protection against overloads and sudden jams.

When the torque rating of the Tork-O-Stat is exceeded, internal parts are disengaged and a complete disconnect results. When the overload or cause of jamming is removed, the unit will reengage and normal drive is resumed automatically. Being a low cost self-contained unit, it can be close-coupled, easily installed, is small in size (only 4¼" dia. by 1 5/16" thick overall), light weight (½ pound), needs no lubrication, is tamperproof, needs no safety guard and is pleasing in appearance for external design uses.

Models are now available with torque ratings of 10, 20, 40 and 60 inch pounds, with their equivalent horsepower ratings dependent entirely upon the speeds used. Although it can be used on all machines and machinery, it is particularly essential on packaging equipment, conveyors, screw-feeds, mixers and other units vulnerable to jamming and overloading. List prices start at $7.95

Gyro Motor

A dime-sized gyroscope motor, probably the world's smallest, has been designed for application where space is really at a premium—on the moving antenna of aircraft fire-control radar. The "inside-out" synchronous motor has a tiny wound stator; the rotor is also the inertia wheel of the gyroscope. This inside-out design, common to gyroscope motors, permits an element with a large polar moment of inertia to be built into a small space. The 2-phase, 400-cycle motor operates on less than a volt per phase, and revolves at 8000 rpm. The gyroscope measures the angular movement of the antenna, enabling computers to calculate firing information.

Ultra Flat Surfaces Help in Electron Studies

Although the multi-billion dollar electrical industry is based on the movement of electrons through metals, there are many, large gaping voids in our understanding of the mechanism of that passage. One of the problems on which research scientists are vigorously working is how conduction electrons (i.e., outer orbital electrons that can be freed to make amperes) absorb energy from impinging light, and how much. The end product of such research still in its early stages, is data for curves from which a theory can be drawn. These results, even these early ones, are of unquestioned value—but not exciting to the average engineer. However, some of the problems and the numbers dealt with in pursuing this data engender high respect for the investigators.

For example, the metal specimens must be polished to a degree that make the surface of even a high-grade telescope mirror look like an array of hills and valleys. The highest "hill" allowed on the surface is about five Angstroms high or 0.00000002 inch. A wavelength of green light is 1000 times greater.

Such super-smooth surfaces are achieved by electro-polishing. This is a relatively old technique by which individual projecting atoms are gently removed. Variations in surface can be reduced almost to the distance between individual atoms.

Giant Condenser

This giant condenser, shown under construction, serves not only its normal function but also as the foundation for the 125-mw turbine above it. It thereby saves several feet of headroom, some foundation construction, and considerable concerete. The 80,000-square-foot condenser is 60 feet long, 24-½ wide, and 14 high. With its super-structure it weighs 1,365,000 pounds. The turbine

Opportunity and Security go arm in arm at Columbia-Southern

Columbia-Southern ranks high as a company in which to make a career.

Columbia-Southern has been happy, too, with its good fortune in adding so many fine men to its organization over the past years.

Columbia-Southern has many inviting advantages. It is rich in opportunity. Columbia-Southern believes in allowing maximum flexibility and personal contact between the individual and his supervisors. The corporation wants each member to progress as rapidly as he can. Responsibilities are increased as rapidly as the individual demonstrates his ability to handle them.

Columbia-Southern has appeal in its security, too. In the nation's complex modern economy, no industry or company can expect to remain unaffected by general business conditions. Because Columbia-Southern's products have diversified applications in many essential industries, Columbia-Southern is less likely than most companies to be seriously affected by a general decline in business activity.

Columbia-Southern is a sound progressive company that abounds in opportunity. We are looking for technical graduates in many fields. If you would like to become a part of the growing Columbia-Southern organization, write Dept. P at our Pittsburgh address or any of the plants.

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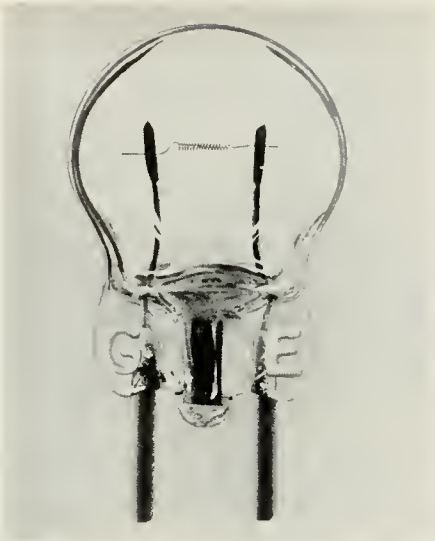
support is 80 feet long and an additional 11 feet high. It contains 5115 sixty-foot-long one-inch tubes—having a total length of nearly 60 miles. It has been installed in the Raritan River Plant of the Jersey Central Power & Light Co.

Miniature Lamp for 'Hot' Appliances

Development of a revolutionary new type of miniature lamp to be used for indicating purposes on "hot" appliances was announced today. The lamp consists of a small glass bubble sealed around a coiled filament, with two rigid pins protruding at the base.

Because it will stand temperatures nearly twice as high as conventional miniature lamps, (600°F versus 350°F) it is expected to find wide use on such appliances as waffle irons, electric casseroles, broilers, fryers, flat irons, toasters, and others where indicator lamps have been impractical or costly before. Indicator lamps are used to show whether an electrical appliance is turned off or on.

Of radically new design, the lamp differs from conventional miniature lamps in that it has no base in the ordinary sense of the word. Rather than a screw base or bayonet base, with their heat-sensitive basing cement and soldered connections, the new construction employs the two bare wire pins for electrical contacts. The lamp's terminals, or pins, will plug into appliance sockets in much the same manner that an electronic tube is inserted in a radio receiver. For the convenience of socket manufacturers, the pins are the same size as those on miniature electronic tubes.



This tiny indicator lamp can be used at temperatures 250° higher than previous models.

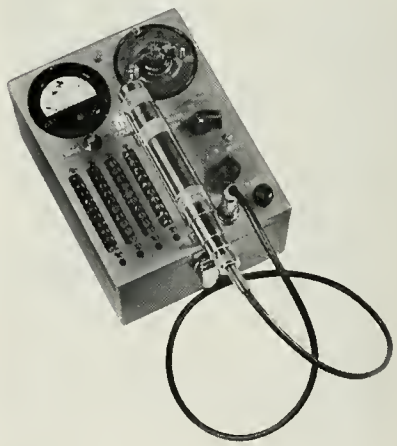
Because of its resistance to heat, the new lamp can be used on appliances where lamps were impractical before, and will give manufacturers greater latitude as to location on other appliances.

Of more rugged construction than conventional miniature lamps, the new bulb will have greater resistance to shock and vibration. Another advantage of the lamp in some applications is that it will permit the exact positioning and orientation of the filament. Although the new construction is expected to be adapted eventually to a wide range of miniature lamp types and sizes, it is being made available at first in a 2.5 volt, half-ampere, 300-hour life lamp. The tiny bulb is only seven-sixteenths of an inch in diameter, and has a maximum overall length of 15-sixteenths of an inch.

Portable Geiger Counter

A portable, lightweight Geiger counter that permits field assay of radioactive substance and gives an accurate, timed count is being introduced.

The counter, called the Countmaster, weighs just 7¼ pounds, including probe and shield. An accurate counting range is claimed up to 12,000 counts per minute. The "find" is flashed upon four rows of tiny neon lights, where it remains until erased by the operator.



This new lightweight Geiger counter has an accurate counting range of up to 12,000 counts per minute.

Introduction of the new instrument, first in a series in the field of radioactivity detection marks the first commercial product of Hoffman Labs, which heretofore has been entirely concerned with advanced research and development and production of electronic gear for the military services. More than a year of rugged environmental and type tests preceded the introduction.

The Countmaster is to be distributed through major mining supply companies and through television distributors. Price is $250.00.

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ALLISON Engineers Break Ground for New Turbine Engine Test Facilities

E. B. NEWILL, Georgia Tech, '15, now General Manager, Allison Division and Vice President of General Motors Corporation, breaks ground on another addition to our turbine engine test facilities.*

Allison Jet engine designers soon will have even larger and improved test facilities to use in developing turbo-jet engines.

Performance requirements for future military and commercial aircraft make necessary the development of new turbo-jet engines far more complex and powerful than present types. New and specially-designed test equipment is required to accurately determine performance of the principal engine components—compressors, turbines, and combustors—before the complete engine is tested.

For instance, capacity for 75,000 horsepower is being established to pump air at the rate of 300 pounds per second. This air must be compressed and heated to 1000 degrees, or cooled to a minus 67 degrees, enabling Allison to test combustors at simulated altitudes up to 65,000 feet.

With our expanding and long-range engineering program, we need additional young engineers. Allison, a leader in the design, development and production of turbo-jet and turbo-prop engines, NOW offers young graduate engineers unusual opportunities for progress where future development is unlimited.

Write for information:

R. G. GREENWOOD, Engineering College Contact

ALLISON DIVISION, General Motors Corporation
Indianapolis 6, Indiana

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* Left to right—Dimitrius Gerdon, Chief Engineer, Turbo-Jets, U. of Michigan, 1932, BS in Mechanical Engineering and Industrial Engineering; T. W. Meeder, Chief Test Engineer, U. of Michigan, 1932, MS in Aeronautical Engineering; R. E. Settle, Assistant Director of Engineering, Purdue University and Indiana Central College, BS in Mathematics; Paul Hunt, representing Huber, Hunt & Nichols, Inc., contractor; E. B. Newill, Georgia Institute of Technology, degrees in Mechanical and Electrical Engineering; Harold H. Dice, U. of Illinois, 1929, BS Business Administration; Col. S. A. Dallas, USAF Plant Representative; R. M. Hazen, U. of North Dakota, U. of Michigan, 1922, BS in Mechanical Engineering and attended graduate school, U. of Minnesota, majoring in Metallurgy.

Technic Teasers

There was recently a sale of various articles of ladies' apparel on the second floor of a downtown department store. A young woman and her grandmother were rushing to get to the sale before the best bargains were all gone. They reached the foot of the escalator going from the first floor to the second floor at the same time and stepped on the first step together. Since they were both in a hurry to get to the sale, they did not stand still and ride the escalator up, but walked up, both at a constant rate, until they reached the top. The young lady forgot that her grandmother could not keep up with her, and walked as fast as she could. The older women was only able to take one step for every three that her younger companion took. Of course, when the young woman reached the top, she had to wait for her grandmother, so she didn't gain anything by her rushing. The granddaughter took 36 steps, her grandmother took 24 steps. How many steps were in sight at one time on the moving staircase?

A church hymn board has four grooved rows on which the numbers of four hymns chosen for the service are placed: The hymn book in use contains 700 hymns. What is the smallest number of numbler plates, each carrying one digit, which must be kept in stock so that the numbers of any four different hymns selected can be displayed; and how will the result be affected if an inverted 6 can be used for a 9?

A man is going to make a trip of 27,000 miles. His tires are guaranteed for 12,000 miles each. What is the least number of tires that he must take (including the four tires on the car) in order to make the trip? Explain.

Once upon a time, there lived a rich farmer who had 30 children, 15 by his first wife, who was dead, and 15 by his second wife. The latter woman was eager that her eldest son should inherit the property. Accordingly one day, she said to him, "Dear Husband, you are getting too old. We ought to settle who shall be heir. Let us arrange our 30 children in a circle, and counting from one of them, remove every tenth child until there remains but one, who shall succeed to your estate."

Quite astonished was the old man, as the first fourteen children eliminated were by his first wife. Noticing this he realized that the odds were 15 to 1 that the latter wife's children would be chosen. "From this point on" the man suggested that they count backward from the lone remaining child from deceased wife. Which became heir? What order did they start?

There are four kegs, all having small leaks. One fills a mug in hours; another fills the same mug in 3 hours; another in 4 hours; and the remaining keg fills the mug in ½ hour. If the liquid being lost from each keg is all funneled into the same mug, how long will it take to fill the mug?

The Problem of the Three Philosophers

Worried about their disputations and oppressed by the summer heat, three Grek philosophers lay down to take a little nap under a tree at the Academy. As they slept, a practical joker smeared their faces with black paint. Presently they all woke up at once and began to laugh at each other. Suddenly, one of them stopped laughing, for he realized that his own face was painted. What was his reasoning?

I have no watch, but I have an excellent clock, which I occasionally forget to wind. Once when this happened I went to the house of a friend, passed the evening in listening to the radio concert program, and went back and set my clock. How could I do this without knowing beforehand the length of the trip?

I had 12 bottles of rare old booze in my cellar (aged over-night) and my wife told me to empty them down the sink, or else; this is what happened:

I pulled the cork from the first bottle and poured the contents down the sink, with the exception of one glass which I drank.

I extracted the cork from the second bottle and did likewise, with the exception of one glass which I drank.

I then withdrew the cork from the third bottle and emptied the good old booze down the sink, except for one glass which I drank.

I pulled the cork from the fourth sink, and poured the bottle down the glass, which I drank. I pulled one bottle from the cork of the next drink and drank one sink out of it, and poured the rest down the glass.

I pulled the sink out of the next glass, and poured the cork down the bottle.

I pulled the next cork out of my throat and poured the sink down the bottle and drank the glass.

Then I corked the sink with the glass, bottled the drink and drank the pour.

When I had everything emptied, I steadied the house with one hand, counted the bottles and corks which added up to twenty-nine.

To be sure, I counted them again as they came by, and this time I had 74.

And as the house came by, I counted them the third time, and finally I had all the houses, bottles, corks, and glasses, except one house and one bottle which I drank.

It wall all my wife's fault.

* * *

Solve the division problems below by finding the correct digits to replace each of the letters.

```
        EFM
        ---------
AQG     FXNQG
        XJM
        ---------
        GXQ
        QAE
        ---------
        AEJG
        ASGG
        ---------
        AQS
```

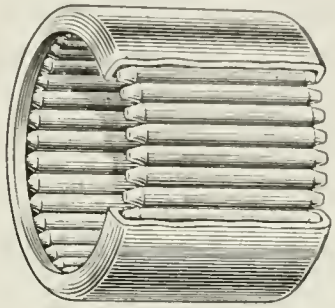
(Solutions on Page 64)

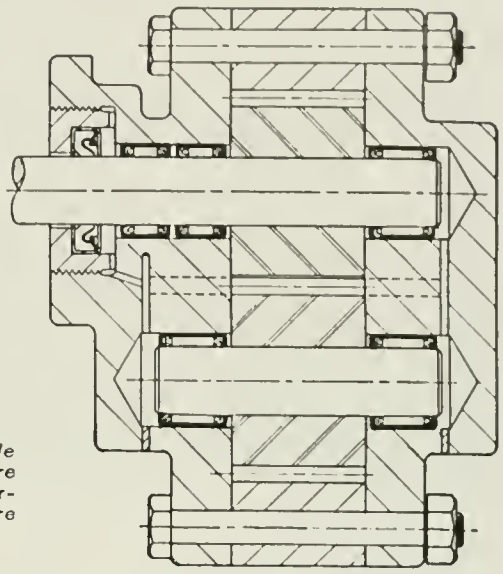
THANKS VERY MUCH, BUT I THINK I CAN MANAGE!

The Torrington Needle Bearing

proper housing design is essential to proper performance

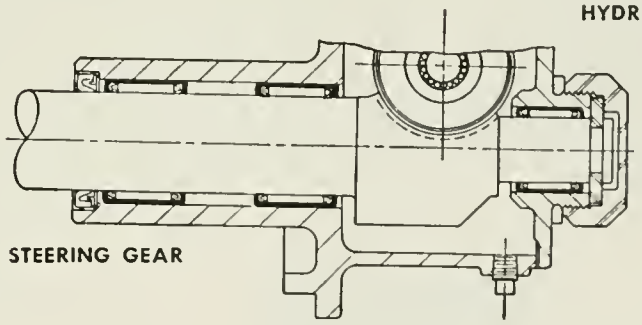
The Torrington Needle Bearing offers many design and operational advantages for a great variety of products and equipment. For example, a Needle Bearing has greater rated radial load capacity in relation to its outside diameter than any other type of anti-friction bearing. It is extremely light in weight. And it is easy to install and lubricate.





HYDRAULIC PUMP

Needle Bearings require simple housings. If the housing bores are held to proper size, accurate operation and high radial capacity are assured.



STEERING GEAR

Housing Maintains Bearing Roundness

The housing is an essential part of the Needle Bearing assembly. Care should be taken to provide a straight, round housing bore to the recommended tolerances.

The thin, surface-hardened outer shell of the Needle Bearing acts as the outer race surface as well as a retainer for the rolls. This shell assumes the shape of the housing into which it is pressed. Consequently, the housing bore should be round, and the housing so designed that it will carry the radial load imposed on the bearing without distortion.

Housing Material Determines Bore Size

The specified housing bore dimensions for any given material should be maintained in order to give the proper running clearance between the needle rollers and the shaft, and to assure sufficient press fit to locate the bearing firmly.

When designing housings of materials that are soft or of low tensile strength, allowance should be made for the plastic flow of the material when the bearing is pressed into place. Bore dimensions in such cases should be less than standard. Needle Bearings can be pressed directly into phenolic or rubber compounds, although metal inserts are recommended.

The new Needle Bearing catalog will be sent on request.

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NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • BALL • NEEDLE ROLLERS

Howard L. Wakeland is an assistant dean in the College of Engineering

(Continued from Page 48)

Besides his teaching, working in the dean's office, and officiating, Mr. Wakeland is very active in the High School Relations Committee which hold Career Days at high schools during the year. After having a very pleasant interview with Mr. Wakeland I can see where he would be very adept for such a committee.

Mr. Wakeland is a member of the American Society of Agricultural Engineers and American Society of Engineering Education. He was advisor to the student branch of the ASAE, and at the present he is an advisor to the Engineering Council.

Besides these organizations he started an Agricultural Engineering Department "Stag Party" several years ago, and this party has been a success each year. The main purpose of the party is for the students and faculty to meet each other in an atmosphere other than the classroom.

STOP-EATER

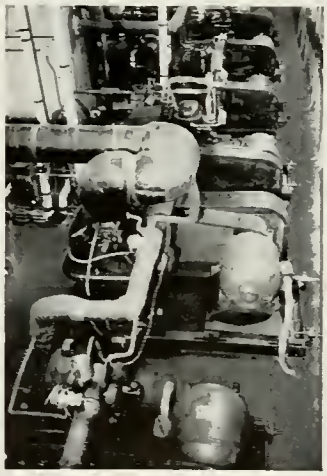
To tell the rotund eater when to stop, Control Engineering suggests a preset strain-gage circuit, mounted neatly underneath the shirt, to register abdominal tautness and start a warning buzzer in the pocket.

ECONOMICAL HINTS

A prominent display of tool and equipment costs, in the form of "price tags" hung or painted on walls or equipment, is contributing significantly to reductions in breakage of machines and tools in several plants. In one Michigan plant, tool breakage has been cut by 20 per cent and there has been substantially less machine downtime.

Believe It or Not: Adam and Eve invented the loose-leaf system.

Below: Six of the fourteen Frick "ECLIPSE" compressors installed in Sperry Engineering Test Department.



Sperry Gyroscope Co. Operates 12 Test Boxes with

FRICK

Refrigeration

At the Great Neck, Long Island, plant of Sperry Co., a dozen environmental test chambers have been equipped with cooling and humidity control, operated by an elaborate low-temperature refrigerating system. This was designed and installed by Tenney Engineering, Inc., Union, N. J., using 14 Frick "ECLIPSE" compressors. Temperatures range from 100° below zero to 200° above.

Whatever your special cooling needs, there's a Frick air conditioning or refrigerating system to meet them with dependability. Let us submit an estimate: write, wire or phone—

For a position with a future inquire about the Frick Graduate Training Course in Refrigeration and Air Conditioning. Operated over 30 years, it offers a career in a growing industry.

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A WONDERFULLY useful plastic called polyethylene* is now giving a new kind of protection to food that is on its way to your kitchen.

WHEN FOOD IS PACKED in thin, strong bags of polyethylene, it is able to "breathe," and yet not dry out. Because polyethylene has this peculiar advantage, apples, carrots, and other fruits and vegetables—as well as poultry and meat products—can reach your table more nearly farm-fresh than ever.

POLYETHYLENE IS ONLY ONE of a number of plastics produced by the people of Union Carbide to help bring foods to you in prime condition. Some of these plastics coat cardboard for milk cartons and frozen food packages, while others line the tins for canned foods and beverages.

SCIENCE "SETS A GOOD TABLE" These and other materials produced by UCC help protect food while growing, in storage, during preparation, when packaged for your use, and when stored in your pantry or refrigerator. This protection helps provide a more healthful diet for all Americans.

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*Pronounced pol'y-eth'ī-lēn

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In addition, Pittsburgh Plare Glass offers unusual security and strength by virtue of being, as a whole, one of the nation's leading "blue-chip" industries.

Pittsburgh Plate Glass gives you the chance to blossom out. It believes in stimulating constructive thinking and action. It wants its men to do the type of work for which they are best suited, in which they are happiest, and in which they can advance to bigger and more responsible jobs in the PPG organization.

With an impressive record of sound growth and an even greater potential ahead, Pittsburgh Plate Glass offers many opportunities in varied fields. Good men are needed. If you would like to learn more about these opportunities, write today to Pittsburgh Plate Glass Company, General Personnel Director, One Gateway Center, Pittsburgh 22, Pennsylvania.

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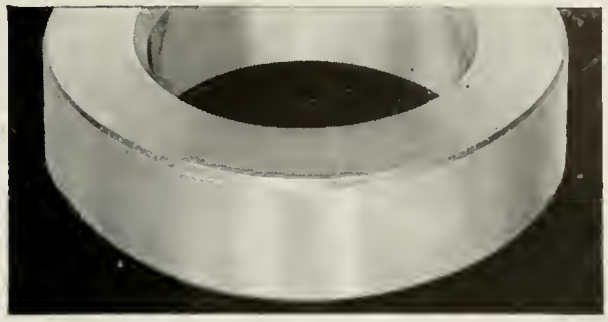
Another page for **YOUR STEEL NOTEBOOK**

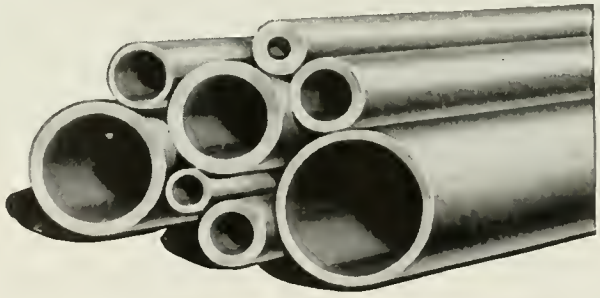
How to make a boring job go faster



With teeth cut into it, this gear blank becomes an engine part. One manufacturer thought these blanks were costing him too much to make. The center hole had to be bored out of solid bar stock. It took one hour to make 29 blanks. A lot of steel was wasted in the process. He took his problem to Timken Company metallurgists. After study, they recommended a change in production methods together with the use of Timken® seamless steel tubing.

How TIMKEN® seamless tubing helped quadruple production

Because the hole's already there in Timken seamless tubing, it doesn't have to be bored out. *No* steel is wasted. Finish boring is now the manufacturer's first step. He can turn out 120 to 130 gear blanks per hour with a 50% cut in machining costs. This is another one of the hundreds of problems that have been solved by Timken fine alloy steel.



Want to learn more about steel or job opportunities?

Some of the engineering problems you'll face after graduation will involve steel applications. For help in learning more about steel, write for your free copy of "The Story of Timken Alloy Steel Quality". And for more information about the excellent job opportunities at the Timken Company, send for a copy of "This Is Timken". Address: The Timken Roller Bearing Company, Canton 6, Ohio.

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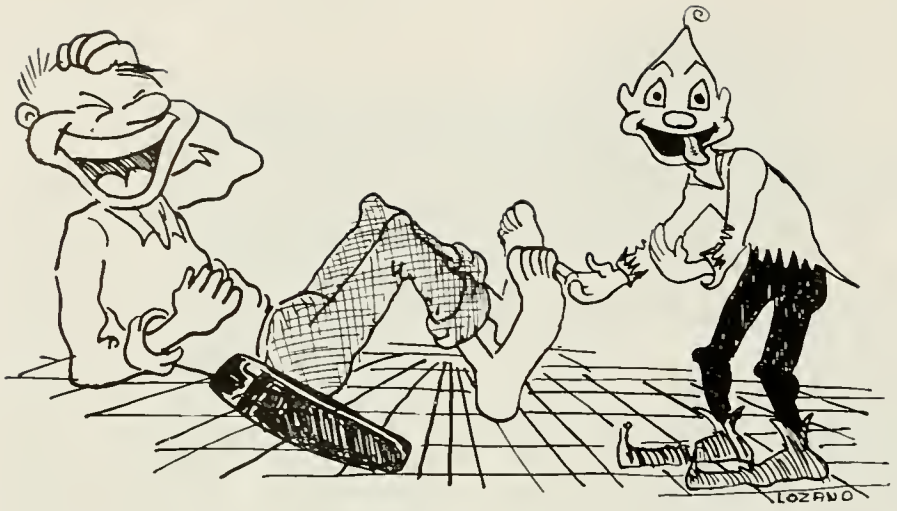


TECHNOCRACKS

Solutions for Technic-teasers Found on Page 58

By logic and trial and error you will find the correct substitutions of digits for letters to be as follows:

```
        246
      ------
178  43928
     356
     ------
      837
      712
     ------
      1258
      1088
     ------
       170
```

* * *

Clock problem:

Before leaving my house, I started the clock, without bothering to set it, and I noted the exact moment A of my departure according to its reading. At my friend's house I noted the exact times, *h* and *k*, of my arrival and departure by his clock. On returning I noted the time B of my arrival according to my clock. The length of my absence was B-A. Of that time *k-h* minutes were spent with my friend, so that the time spent in traveling, *t*, in each direction, was $2t \pm (B\text{-}A) - (k\text{-}h)$. Thus the correct time when I got home was $k + t$.

* * *

Tire problem:

By alternating one tire every 3,000 miles the trip will require nine tires, all of which will have their full life used up.

* * *

Keg problem:

Let m equal mug's capacity; t equal time. Then the rates of flow from each keg are m 2, m 3, m/4, and 2m respectively. The total plus m 4 plus 2m equals 37m 12. Then 37mt 12 equals m. It follows that t equals 12 37 hour.

* * *

The Three Philosophers:

A, B, and C are the three philosophers. A thought: "Since B laughs he thinks his face is clean. Since he believes that, if he saw my face was clean also, he would be astonished at C's laughter, for C would have nothing to laugh at. Since B is not astonished he must think that C is laughing at me. Hence my face is black."

* * *

Inheritance problem:

The second wife's eldest son inherited the property. They started in any order as long as the second wife's eldest son is 29th man from original starting position.

* * *

Hymn problem:

The smallest number of plates which must be kept in stock is 86; if an inverted 6 can be used for an 9, 81 are needed.

* * *

Escalator problem:

There are 48 steps in sight at one time on the moving staircase.

It's tough to find
For love or money
A joke that's clean
And also funny.

* * *

Prof.: "When the room settles down I'll begin my lecture."

Student: "Why don't you go home and sleep it off?"

* * *

Two mosquitoes were resting on Robinson Crusoe's arm. "I'm leaving now," said one. "I'll meet you on Friday."

ROTC Student: "I haven't pencil or paper for the examination."

Sergeant: "What would you think of a soldier who went into battle without his gun or ammunition?"

ROTC Student: "I'd think he was an officer."

* * *

A farmer brought some produce to town and sold it. He thought, "I will surprise my wife." He bought a suit of clothes, a hat, a pair of shoes, and put them under the seat of his buggy. On the way home, he stopped at the river, where he took off his old clothes and threw them in. Then he looked under the seat, and found his new clothes gone. Shrugging his shoulders, he got into the buggy and said, "Git up Maud, we'll surprise her anyway."

* * *

Confucius say, "Modern woman putting up such a false front, man never knows what he is up against."

* * *

A window washer related this experience to his friends: "One day I was cleaning a window when a young woman entered and started to undress She took off her shoes and stockings and then her dress when suddenly the ladder broke."

"What a calamity at a time like that," remarked one of the listeners.

"It sure was," answered the window washer, "but what could you expect with twenty guys on the ladder?"

* * *

OHM ON THE RANGE

Opus 314—In Three Phase Time

Oh give me an ohm
Where the impedances roam
Where the fields are not fluxing all day,
Where you'll never see
A field without phi,
And the flux is not leaking away.
Ohm, ohm on the range,
Where the flux is not charging all day;
Where never is seen
A shunt field machine
With its armature running away.

* * *

"Cheer up, old man. Why don't you drown your sorrow?"

"She's stronger than I am, and besides, it'd be murder."

* * *

A woman got into a cab and told the driver, "Quick, get me to the fraternity ward!"

"Don't you mean a maternity ward?"

"Oh yes, I guess I do. But hurry, I have to see an upturn."

"Upturn? Don't you mean intern?"

"Fraternity, maternity, uptern, intern, just step on it. I think I'm stagnent."

Richmond Station of the Philadelphia Electric Co.

Weeks of work shrink to days as

photography weighs mountains of coal

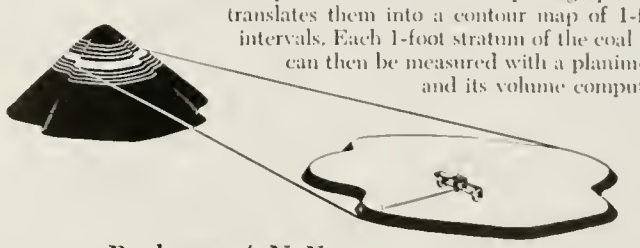
Aero Service Corporation takes stereo pictures of the coal piles at a utility's 10 storage sites—reports the fuel reserves on a single inventory date at 25% lower cost than with other methods

It used to take a surveying crew weeks to measure and figure the contents of the Philadelphia Electric Co.'s big coal piles. Now a camera and an airplane work together to cut the time to days. Overlapping pictures are taken from the air. Then with stereo plotting equipment the volume of the heap is calculated.

Streamlining the inventory job is a natural for photography. It's being used to count metal rods, automotive parts, telephone calls as well as tons of coal. But photography works for business in many other ways as well —saving time, reducing error, cutting costs, improving production.

Graduates in the physical sciences and in engineering find photography an increasingly valuable tool in their new occupations. Its expanding use has also created many challenging opportunities at Kodak, especially in the development of large-scale chemical processes and the design of complex precision mechanical-electronic equipment. Whether you are a recent graduate or a qualified returning service man, if you are interested in these opportunities, write to Business & Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.

Aero Service Corporation takes its stereo photographs and translates them into a contour map of 1-foot intervals. Each 1-foot stratum of the coal pile can then be measured with a planimeter and its volume computed.



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What will you add to jet engine progress?

New, dramatic advances being made at General Electric's aircraft gas turbine operations bring into clear focus the vital role recent college engineering graduates play throughout the company. Typifying such responsibility are R. W. Bradshaw, ME, Lehigh, '48, responsible for design of development engine controls and accessories, and B. C. Hope, EE, UCLA, '49, supervisor of test programs for development of aerodynamic and mechanical components.

In every field from electrical, mechanical, metallurgical and aeronautical engineering to physics and chemistry, young men like these broaden their technical background in GE's after-college program of practical engineering assignments. In this program, as in his ultimate career, the engineer chooses the field and location—from the entire range of G-E activities including plastics, large electrical apparatus, electronics, jet propulsion, automation components and atomic power.

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ILLINOIS TECHNOGRAPH

APRIL, 1955

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John F. Holt, class of '47

speaks from experience when he says . . .

"Expanding research and product development at U. S. Steel mean more opportunities for qualified engineers"

SINCE 1952, John F. Holt has been Assistant Superintendent of the Coke and Coal Chemicals Department at United States Steel's new Fairless Works in Morrisville, Pa. He started working at U.S. Steel—as a trainee—in 1947. That's a lot of progress in just five years. For in his present position, John is responsible for both the quality and the quantity of all coal chemicals produced at the Fairless Works – about 3,500,000 gallons of light oils per year. 190 hourly employees and 25 supervisory personnel report to him.

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If *you* are interested in a challenging and rewarding career with United States Steel and feel that you can qualify, you can obtain further information from your college placement director. Or we will gladly send you our informative booklet, "Paths of Opportunity," upon request. Just write to United States Steel Corporation, Personnel Division, Room 1622, 525 William Penn Place, Pittsburgh 30, Pa.

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A CAREER MORE THAN A JOB is the philosophy behind Hercules' personnel policies. To assist employees in their efforts to attain security for themselves and their families, Hercules' personnel program includes a liberal vacation plan, a disability benefit plan, accident and sickness insurance, a hospital-surgical plan, group life insurance, and other benefits. A comprehensive personnel program is only one of several good reasons why many turn to Hercules for positions with a future.

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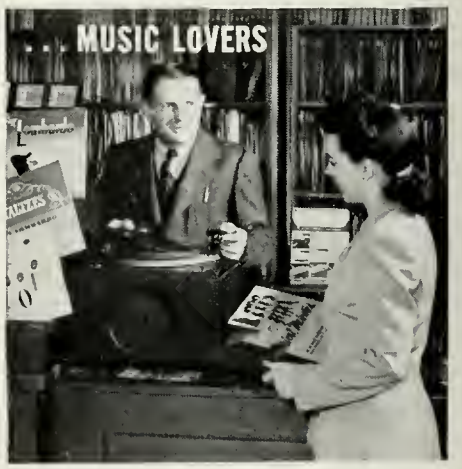

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For a starter, we'd point out that young engineers have an admirable chance to follow their natural bent in a company like GM—which manufactures products ranging from cars and locomotives and earth-movers all the way to household electrical appliances.

On top of that, GM's extensive decentralization into 121 plants gives our young engineers an unusually fine opportunity to work in locations of their choice. Besides, this policy provides the chance to learn and win recognition while working with a close-knit engineering team.

And for the record, we'd like to make mention of GM's incomparable resources and facilities. While each of GM's 35 manufacturing divisions has its own, they can all draw on vast central research facilities.

But most important, remember that GM thrives on engineering achievements—constantly seeks to produce more and better things for more people. Hence, there's a really stimulating creative climate that's ideal for men with enthusiasm and imagination.

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GENERAL MOTORS CORPORATION

Personnel Staff, Detroit 2, Michigan

A WHIRLPOOL SPIRALS into the inlet of a model pump. This unique picture shows how air, a common cause of pumping trouble, was carried into the pump in . . .

The Case of the Baffled Whirlpool

Some time ago, the report reached us that two Worthington vertical turbine pumps installed by one of our customers weren't working right. They delivered plenty of water, but vibrated badly and burned out bearings.

The customer asked us to find the trouble fast. After checking we knew the pumps were okay, so Worthington Research had to answer him.

First thing we did was build a one-tenth scale model of the customer's installation. The photo shows what happened when we started pumping.

A whirlpool immediately formed between the water surface and the pump inlet. Air, trapped in the whirlpool and carried into the pump, was the villain in the case.

The solution came with experimentation. A simple baffle arrangement in a side channel eliminated the whirlpool—and the trouble-making air.

Chasing the gremlins from pump installations like this, boosting the efficiency of heat transfer in air conditioners, developing better seals for pumps and compressors — these are all in the day's work for Worthington's busy research engineers. At Worthington, research ranks right alongside engineering, production, and sales to develop better products for all industry.

For the complete story of how you can fit into the Worthington picture, write F. F. Thompson, Mgr., Personnel & Training, Worthington Corporation, Harrison, New Jersey. 4.25C

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Your Greatest Security . . .

All of you, no doubt, ask about security when you seek a job. How much you want to pay for security is a matter for your own choice. It is wise to consider the fact that you have already paid for a great amount of security. Your education and good sense are your greatest security. This is something you can't buy, but you already have it. Nothing pays off in security like competent work and the ability to get along with people.

With an engineer's education, the price of security is very cheap. Employers are more anxious to keep you than you are to work for them. Employers recognize the high cost of training new personnel.

Security can be costly. Civil service and armed services offer a lot of security, but it cuts down take home pay. Security has to be costly because it is a guarantee that you won't be fired if you don't make the grade. Therefore your talents are underestimated and you are paid accordingly. If you have confidence in your engineering ability, you need less security than one who has less confidence in himself.

The chances for advances are worth much more than security. Advancement is a company policy and should not reflect starting salary. Since the company loses nothing, they don't take it out on your pay. The thing to be sure of is that the company has a policy of promotion from within its ranks. When a company has this policy, they are more careful to watch for those who are qualified for advancement. In this company you have a lot better chance of being recognized than in one which hires an outsider to fill a position.

In all you do, your efforts will be recognized and they will tell whether you have confidence in yourself, or loaf or do careless work. Your greatest asset is your initiative. Use it to your fullest extent.

D. F. K.

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PPG wants good men in varied fields. It has much to offer you from the very beginning and all during the time you are building your future.

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MISSILE SYSTEMS

Research and Development

Physicists and engineers at Lockheed Missile Systems Division are engaged in a group effort covering virtually every field of science.

Missile Systems Division scientists and engineers discuss a new missile systems concept in light of tactical requirements. Left to right: Dr. H. H. Hall, nuclear physicist; I. H. Culver, systems development division engineer; Dr. R. J. Havens, research scientist; W. M. Hawkins, chief engineer; Dr. Ernst H. Krause, nuclear physicist and director of research laboratories; S. W. Burriss, experimental operations division engineer; Ralph H. Miner, staff engineering division engineer; and Dr. Eric Durand, nuclear physicist.

Continuing developments are creating new positions for those capable of significant contributions to the technology of guided missiles.

Lockheed MISSILE SYSTEMS DIVISION
research and engineering staff

LOCKHEED AIRCRAFT CORPORATION • VAN NUYS, CALIFORNIA

Vital link between thought and action paces all military and industrial activity

RADIO COMMUNICATION, oldest of the electronic sciences, has long played an important role in the thought-action process; yet today it is being called upon for capabilities and performance characteristics far beyond those afforded by the present state of the art.

Such demands stem from the basic importance of advanced communication systems in maintaining American military superiority.

Recognizing this, The Ramo-Wooldridge Corporation is today engaged in research and development activities leading to the production of radio communications systems capable of providing the *information capacity, versatility, range,* and *reliability* necessary to insure maximum performance of our weapons systems.

And yet the challenge is not all military. It is inevitable that the application at Ramo-Wooldridge of these advanced modern theories and new techniques will lead to significant accomplishments in the field of commercial communications as well.

Engineers and physicists qualified to undertake advanced work in systems analysis and engineering, circuit development, transmitter and receiver engineering, modulator development, and propagation studies are invited to investigate the opportunities existing in HF and microwave communications, data transmission, facsimile, and allied fields, awaiting them at Rama-Wooldridge.

The Ramo-Wooldridge Corporation

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THE ILLINOIS TECHNOGRAPH

volume 70 number 7

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our cover

The Pontiac Stratostreak V-8 engine is a typical example of the great strides that have been made in the field of automotive engine design. This 180 horsepower package is more than just an outstanding engineering achievement. From hydraulic valve lifters to quad- galley lubrication; from ball-pivot rocker arms to reverse flow gusher valve cooling — all represent man's effort to better himself. (Color cover-plates courtesy of Pontiac Motors Division, General Motors Corporation.)

our frontispiece

The 1955 Jaguar convertible was shown at the Champaign-Urbana Optimist Club sports car show. This XK-140-M is slightly modified in the engine compartment and has four seats.

More than Just Transportation

by Don F. Kesler, E. E. '56

The main difference between hot rods and sports cars is the method of attaining the common goal. The goal is performance and safety.

The approach of the hot rodder is to take big American cars and do as much for them as possible. Great improvements are made on the existing cars, however, the limiting factor is the starting point of the basic car.

The sports car fan attacks the problem from the foundation. The basic car is designed with competition and road work in mind. Since a car is of little use unless it can be driven on the street, all street equipment is necessary. It must have complete headlights, tail lights and a horn. Also it must be equipped with a spare tire and fenders. If the fenders are the cycle type, they must cover at least an arc of 120 degrees along the wheel.

Sports cars must be built to be driven on service station gasoline, since this is what is allowed in sponsored sports car races. The only gasoline that may be used is furnished by the officials, so that rules out all alcohol and nitro mixtures. It also keeps sports car racing from getting out of reach of many would be enthusiasts. Any carburetor, cam, or manifold modifications are legal in all except strictly stock classes.

The job of a sports car in competition is to get the driver from one point to another point in the shortest time for a given engine size. To do this job, it is essential that the car corners well and accelerates well.

There are many factors concerning cornering. A firm suspension is one of the first. It takes a firm suspension to counteract the roll caused by the moment of the center of gravity acting about the roll center. Obviously there are two ways to cut down roll—lower the center of gravity or raise the roll center. So the job is to do both. Lowering the center of gravity is merely getting the weight as low as possible, however there are more variables in raising the roll center. The variation in roll center comes from different types of suspension. In general, the SFA (solid front axle) has a higher roll center than any IFS (independent front suspension). The roll center on the SFA is at the spring perch. The roll center on the IFS ranges from below the ground to a few inches above the ground depending on the individual design. One exception to this is the Allard front suspension, which has a high roll center. This is essentially a solid axle that has been cut in the middle and pivoted at both ends at the center of the frame. It also has radius rods. Even though it has a high roll center, very little can be said for the Allard handling qualities.

The Porsche has a very good suspension that is different. It has four wheel independent suspension with about nine inches wheel travel. The employment of trailing link suspension makes possible the soft ride with horizontal stability. Torsion bars parallel to the axle produce the spring action. The wheels follow the torsion bars like swivel castors without the swivel. The action of the wheel is vertical with a little action forward and backward due to the arc about the radius of the offset between the torsion bar and the axle. This takes out most of the roll tendencies of the conventional "A" arms that are used on most American cars. It is impossible to imagine such a soft ride, yet such excellent cornering qualities. There is no thrust on the steering wheel over rough roads at speeds of over 110 miles an hour. The Volkswagen, which sells for under nine hundred dollars in Germany, or about sixteen hundred dollars here, also uses this type of suspension. An American manufacturer cannot imagine a car with four wheel independent sus-

Benjamin F. Harris III's custom built special. The car utilizes two four cylinder Austin engines mounted on a single crankshaft in the form of a V-8.

pension being produced for under nine hundred dollars. It is a fact that the Volkswagen ranks fourth in car sales in the world. This puts it just after Ford, Chevrolet, and Buick.

Roadholding as well as riding qualities come from a high sprung to unsprung weight ratio. That is done by having the lowest possible weight of the axles, wheels, and springs. Torsion bar suspension removes the weight of the spring from the unsprung weight. Independent suspension removes the weight of the axles and more important, the differential and driveshaft. A low unsprung weight reduces the inertia the body must stop when the wheels go over a bump. Thus a reduction in unsprung weight reduces bumps in direct proportion to the decrease in unsprung weight. This improvement in ride in no way hampers road holding qualities. In fact it improves them by reducing the amount of time the wheel is off the ground after the car goes over a bump. More torque is transmitted to the road and the cornering is improved.

The ability to go into a controlled drift is a very important factor in cornering. Dritting is a mild slide by all four wheels that enables power to be applied and cut down the amount of body roll. The amount of drift is very easily controlled by the amount of power applied to the rear wheels. The size of tires, tire pressure, spring rate, available torque, and type of suspension are all important factors in controlled drift. The inherent ability comes from the type of suspension and spring rate, but this can be varied to a certain extent by the area of contact of the tires and tire pressure. The center of gravity is highly important in the amount of drift. If the center of gravity is high it will take a large amount of torque to make a given car drift. With a lower center of gravity, the car will drift with a lesser amount of torque or will slide more for the same amount of torque. Ordinarily, there is little concern in getting the center of gravity too low. This is unusual, but can easily be done with small cars with a solid axle.

It is generally recoguized that the rear spring rate should be about sixty per cent of the front spring rate. This means the rear springs are softer and allow most of the roll to be counteracted by the front wheels. Thus there is less rear wheel pickup, and less wheel spin on the corners. In turn, there is more torque, and better cornering. This also helps the ride since the driver is sitting very close to the rear wheels in a sports car. The leverage of the front wheels on the driver is small compared to that of the rear wheels. The shock transmitted to the driver is proportional to the leverage and the stiffness of the springs. Therefore the springs may be much stiffer in front than the rear and still not make the ride appreciably worse.

Acceleration is almost completely dependent upon weight, horsepower, and gear ratio. Aside from the drag, acceleration is proportional to torque divided by the weight. A cut in weight reflects an equal per cent gain in acceleration. A good, or fat, horsepower curve is just as important as high peak horsepower. Horsepower is in the lower RPM ranges is used much more than in the peak range.

Since sports car competition is based on engine size, boring and stroking should not be carried out so as to put you in the bottom of the next highest displacement class. The RPM of peak horsepower is not of importance if no more horsepower can be attained at more RPM's. Where a high RPM engine is used, a lower gear ratio is used so the final torque is only dependent on horsepower and not on engine speed.

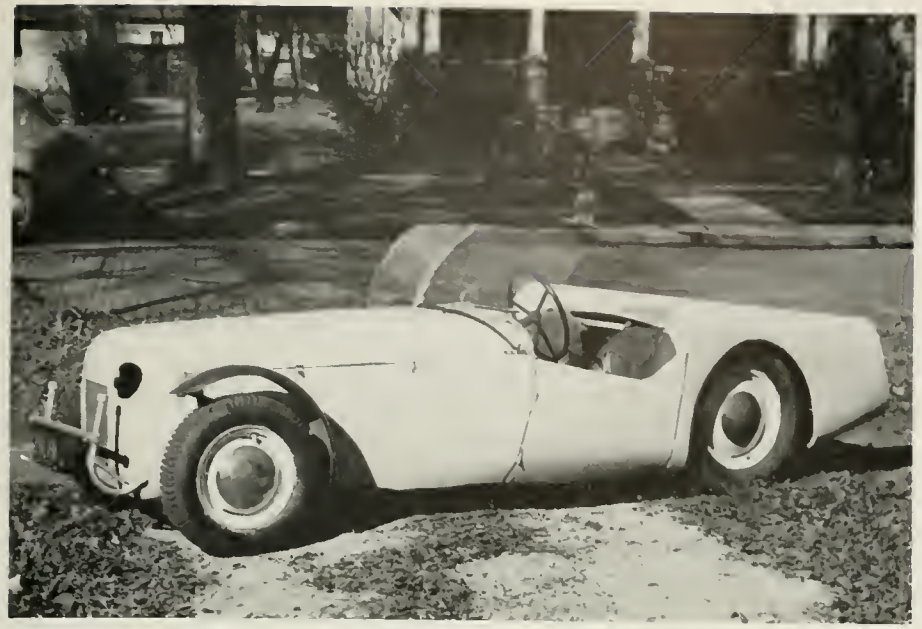
American cars violate almost all rules of good performance. The cars are heavy, have poor aerodynamics, are too large to handle good, and have poor weight distribution. The steering ratio is too high, the tires are low pressure, the center of gravity is high, and the roll center is low. Most of the transmissions are automatic, which cause poor control of gearing and power curves. The one thing that can be said for American cars is the high horsepower engines, however, the displacement is so large that they cannot be called high output engined by any stretch of the imagination.

The hot rodders are to be congratulated for what they have done for their cars, however they must be compared to a Ferrari of comparable engine size. The largest Ferrari is under 300 cubic inches. Even with the difference, the Ferrari went 180 miles an hour in the Mexican road race. The Monza and Mondial Ferrari (183 cubic) can top the 4.9 on short courses. The hot rods cannot come close to these cars of only a half their engine size.

A sports car is fun to drive because it is responsive to your command. The easy steering comes from good weight distribution and light weight. Fast steering means quick response, because the driver does not have to turn the wheel so far. Brakes that never fade are essential on a competition car. Light weight, large lining area, and large diameter brakes reduce the strain in long races. Disc or spot brakes are very effective in combatting fade. Aluminum alloy with steel liners make brakes run cooler than cast iron brake drums. Braking from 150 to 30 miles per hour takes the toll of cars with good brakes. The Jaguar has three spots per wheel spot brakes on its competition models. The patent is licensed from a U. S. company. Why can't U. S. car manufacturers make use of these superior brakes. These are but a few of the engineering advances of the European cars.

A few weeks ago, several enthusiasts from the local area went on a rally to Starved Rock, Illinois. A rally is not a race in any way, shape or form. The

William Doty won a ribbon and o silver plate with his Triump TR-2 at the sports car show. (Photo courtesy Joe Stocks, Champaign-Urbana Optimists Club)



This little class H car was built by Don F. Kesler last summer. The car has an aluminum body and modified Crosley frame and suspension. The engine is a madified Crosley.

object of a rally is to maintain an average speed over a route that is unknown to you. This is no easy thing to do. Your navigator is madly making calculations while you worry about whether you are early or late. Now you shout more things for your navigator to calculate. You are watching unmarked roads and hope you hit the right one. Always on the lookout for secret check points, you ask about your time. The secret check points dictate that you always maintain the average and don't speed up and wait until the right time to get to the check point.

At the finish, the times and distances are compared to determine the winner. The person with the least deviation from the predetermined average wins. Phil Raeder, the winner of the Starved Rock rally, was only twelve seconds off after the first check point at thirty-two miles. Phil drove an MG-TF 1500. Don Westerberg took second in his MG special. Third place went to Bob Kay in a Jaguar.

Events would be a lot easier to plan if there was a sports car club in the Champaign-Urbana area. Regular meetings would draw more interest and would make it easier to delegate jobs necessary to stage an event. Other advantages of organization are discounts, movies of Sebring, G. P., and other races. These movies are available to clubs and are very good. A club keeps the group closer together by getting everyone together at once and saves time by not having everyone stop to find out about a coming event. News would circulate faster, and get to everyone.

The first job in organizing a sports car club is to advertise a meeting by placing notices on all sports cars and by word of mouth. Then bring some ideas about your club rules and requirements to the first meeting. Set up your constitution the first meeting so as to have a vote the second meeting. Get a committee started to stage a rally before a month. It is important to stage an event shortly after the start of the organization so that interest will not be lost.

Rallies can be staged to sports car races, state or national parks, or other interesting places. A small club is holding races on and surrounding a quarter mile track near Macomb, Illinois. A similar thing could be done near any quarter mile track, or abandoned airport. The Champaign County Fair Grounds has been used for a sports car field day.

The next thing to do is to keep the organization running smoothly. One of the best ways to do this is to show movies at the meetings and to bring a well known driver or organizer to the meeting in order to discuss secrets of staging events.

A sports car club is a good way to spread good publicity and to strengthen the field of sports cars. Every effort should be taken to further the acceptance and widespread use of sports cars. So far Detroit has made very little use of the latest developments found on sports cars. Perhaps with the growth of sports cars in America we will have some requirements such as four wheel independent suspension, overhead cams, and close ratio gears on American cars. When that day comes hot rodders will have good equipment to work with. But until that day, sports cars have the supreme advantage over hot rods.

Walking with a friend one day, a professor passed a large fish shop where a fine catch of codfish with mouths open and eyes staring were arranged in a row. The professor suddenly stopped, looked at them and(clutching his friend by the arms, exclaimed: "Heavens! That reminds me I have a class in CE this hour."

* * *

An engineer is a guy who is educated in the art of developing new and different ways of making the same mistake.

* * *

A small boy was seated on the curb with a pint of whiskey in his hand reading a racing form and smoking a big cigar.

An old lady passed and asked, "Little boy, why aren't you in school?"

The child replied: "Geez lady I ain't but four.

* * *

Teacher: David, what does F-E-E-T spell?

David: I don't think I know.

Teacher: Well, what is it that a cow has four of and I have only two?

The class was dismissed.

* * *

Leroy Brooks was assigned the job of writing up his senior class play in the high school paper. He came in for his share of literary fame when this write-up was published:

"The auditorium was filled with expectant mothers eagerly awaiting the appearance of their offspring."

* * *

Take for example rags. Rags make paper. Paper makes money. Money makes banks. Banks make loans. Loans make poverty, and poverty makes rags.

* * *

Mose was brought up for the fourth speeding offense. He muttered something under his breath that sounded like an oath.

"Repeat that," snapped the judge.

"Oh, I says, 'God am de judge, God am de judge.'"

* * *

OHM ON THE RANGE
OPUS 314—IN THREE PHASE TIME

Oh give me an ohm,
Where the impedances roam,
Where the field are not fluxing all day.
Where never you'll see,
A field without phi,
And the flux is not leaking away.
Ohm, ohm on the range,
Wheer the flux is not charging all day,
Where never is seen
A shunt field machine
With its armature running away.

THE ALUMINUM INDUSTRY WAS BORN ON SMALLMAN STREET

▼ In 1888, the aluminum industry consisted of one company—located in an unimpressive little building on the east side of Pittsburgh. It was called The Pittsburgh Reduction Company. The men of this company had real engineering abilities and viewed the work to be done with an imagineering eye. But they were much more than that. They were pioneers . . . leaders . . . men of vision.

A lot has happened since 1888. The country . . . the company . . . and the industry have grown up. Ten new territories have become states, for one thing. The total industry now employs more than 1,000,000 people—and the little outfit on Smallman Street? Well, it's a lot bigger, too—and the name has been changed to Alcoa. ALUMINUM COMPANY OF AMERICA . . . but it's still the leader—still the place for engineering "firsts".

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ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

Hard Rock Shores of Lake Superior are Blasted for New Taconite Harbor

A new harbor for the transportation of taconite ore is being blasted out of the hard rock shore of Lake Superior, 75 miles north of Duluth, Minn. The operation is part of a $300-million project which will start feeding taconite to the nation's steel industry by 1957.

Construction of the 30-foot-deep harbor and its 2,444-foot-long concrete wharf requires the removal of approximately 1,000,000 cubic yards of rock over a 35-acre area, much of it under water. Three United States companies and one Canadian company own the Erie Mining Company which is responsible for the project.

The harbor is approximately 4,900 feet long and 1,500 feet wide. Two small islands joined by a rock breakwater will form the outer protection, and other rock breakwaters extending outward from the shoreline will safeguard the sides. Ships will enter one end of the harbor between the breakwaters and leave through the other end.

Contracting work began on the harbor in May, 1954 and is expected to be completed sometime in 1956. The harbor probably will go into operation late in 1957 when the Erie Mining Company's processing plant for taconite, 73 miles inland, is completed.

A new railroad will deliver taconite ore pellets, processed at the plant, to the harbor for loading into lake carriers. Ore cars will travel on a railroad trestle above the bins to discharge their contents. Lake freighters will be unloaded directly from the bins by means of conveyors.

To facilitate blasting and rock removal for the harbor, two cellular steel sheet pile cofferdams (watertight enclosures from which water is pumped to expose lake bottom) are being built around the excavation areas. The first cofferdam was divided into two parts so excavation could be carried on in one area while the second part of the cofferdam was being constructed. After the first portion of the main cofferdam was completed, water was pumped out and blasting began.

The harbor will be excavated to leave a vertical wall of rock which will be faced with concrete to form a solid dock. The ore-loading wharf is 1,200 feet long. On it will be mounted 25 concrete bins for loading taconite. Thirteen additional bins can be built on a 624-foot extension of the dock later on.

And then there was the E.E. who called his girl "Carbon" because her resistance went down when she got warmed up.

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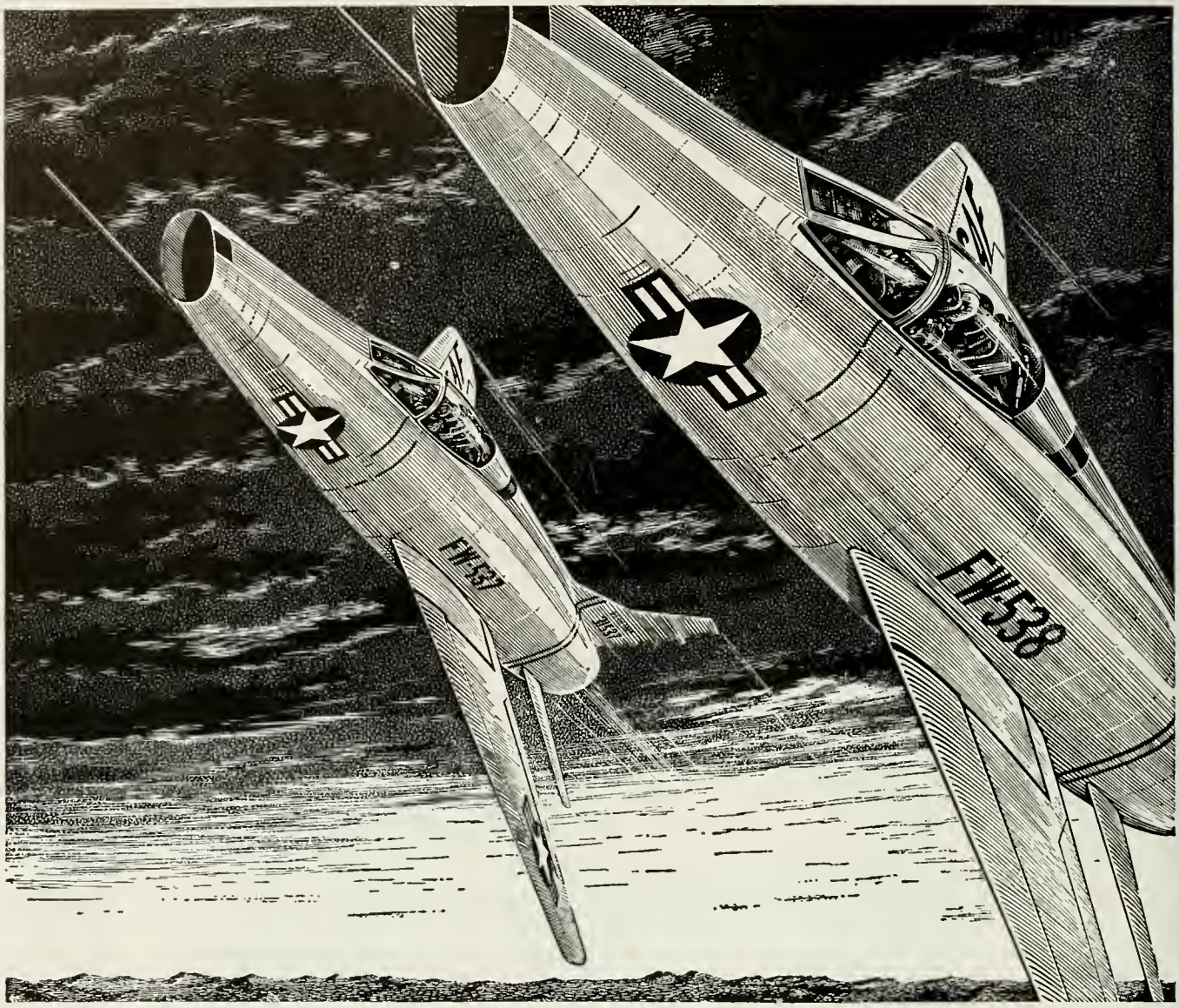

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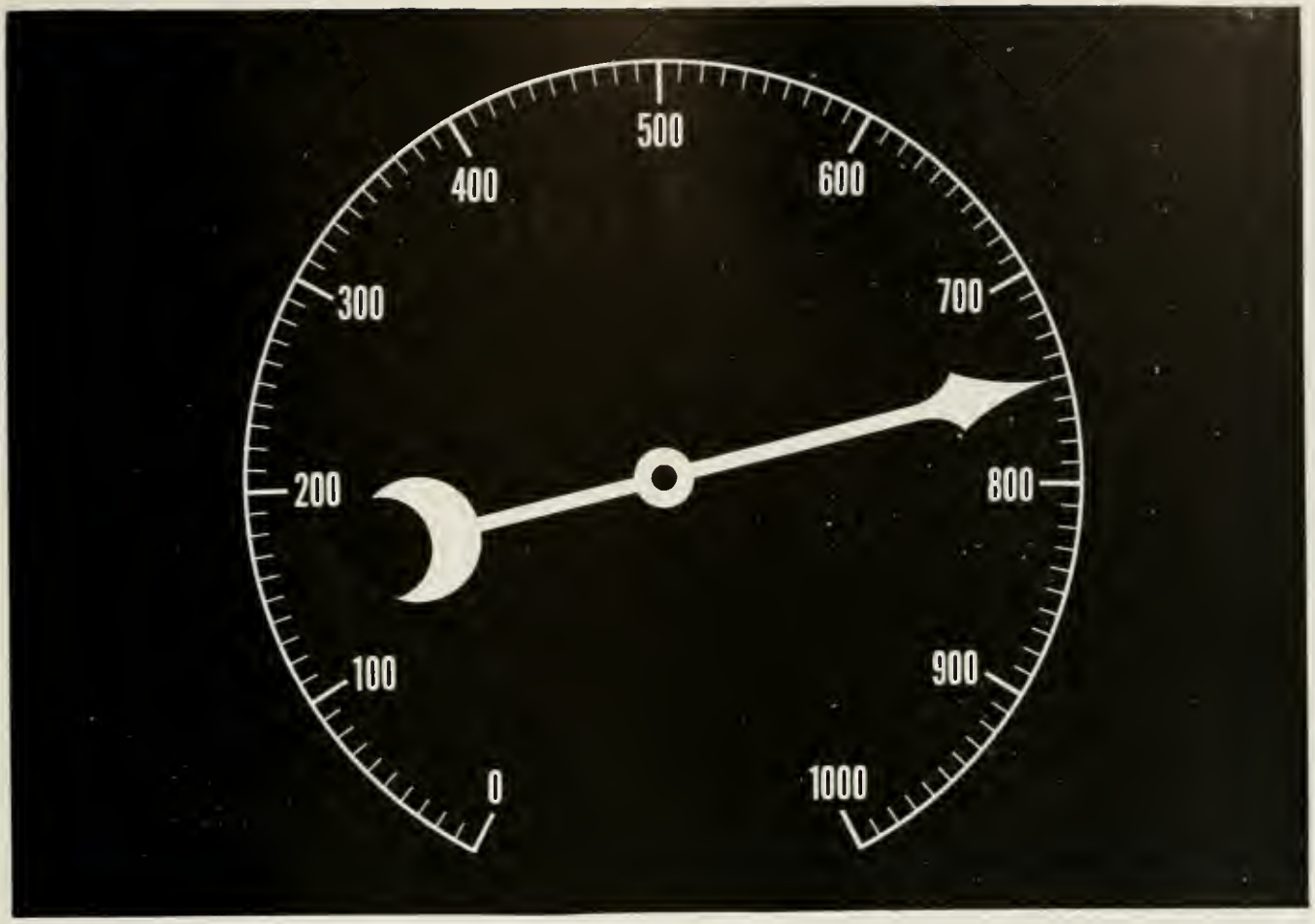

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Go – Daddy Go!

by Donnie Snedeker, E. E. '58

"Drag, Buddy?" This simple often-heard phrase seems to exemplify the enthusiasm for a sport and a hobby that has taken hold of 50% of today's young men. More and more teen-agers are flying along this hopped-up highway to speed and power. They aren't content driving a Detroit wagon that will meet its waterloo at every stoplight. They want a car with super looks and super go-go-go.

Often times the beginner who sets out to soup up his car becomes lost in a maze of fact, formulas, and fantasies. He doesn't know where to begin to get the most for his dollar. As little or as much can be done as the individual wants, with prices ranging from a few dollars to have the heads milled to hundreds for the complete treatment. Basically there are five simple ways to power and speed which I shall attempt to elaborate here.

The first thing that invariably pops into the head of the newly-converted speed merchant is to either mill the heads, or replace them with a set of high compression heads. The increase in compression ratio shows a gain of 10 horsepower immediately. The performance becomes improved and the engine should operate more economically. All this is brought about because the gas is being compressed more, giving it a greater punch when it is ignited. As I mentioned before this increase in compression can be accomplished by installing a set of special high compression heads. The cost would probably run nearly $75. For less than one-third this price the heads can be milled (part of the underside of the head is machined off to reduce the volume of the combustion chamber), and for all practical purposes on a street job this gives almost as much increase in power as a set of aluminum racing heads. The average late model car has a compression ratio of about 6.8 to 1. Milling 0.120 in. off the head will increase this compression ratio to about 8½ to 1. Although you can go as high as 14 to 1 with special domed high compression heads, 8½ to 1 is about the best for general use on a street job burning pump gas. Any higher ratio would tend to give very poor low speed performance.

Second on our agenda to speed and power comes the cam shaft. No other single souping operation can add as much moxie to an engine as the installation of a high-performance, reground cam shaft. Many types of high-performance cams and regrinding operations are offered to the public, but for best performance the cam shaft should be reground to suit the individual engine. The semi or ¾-race grind is about the best-suited for passenger car use. It will work hand in hand with the high-compression heads to give increased power, performance, and acceleration while maintaining good low speed and idling characteristics. The function of the reground cam is to give the valves higher lift, longer opening, and more overlap. This produces greater volumetric efficiency which in turn nets up to 10 additional horsepower. The cost of the regrinding operation runs around $30 to $40 with very little means of cutting down on costs here. However, Chevvy owners can get around grinding the cam by using special high-lift rocker arms, instead. These perform the same function of holding the valves open a little longer, as does the racing cam, and they only cost $12.75 a set. V-8 owners should install a set of adjustable tappets with their reground cam to compensate for the amount of metal ground off the cam lobes.

The next thing that needs looking into is seeing that each cylinder gets as much fuel and air packed in with each intake stroke as possible. Most simply this is achieved by multiple carburetion. Aside from changing to smaller jet sizes, the stock automobile carburetor is very well-suited to this purpose. Whether dual or triple carburetion is used, the carburetors should all be of the same make and size. For proper distribution of the fuel to each cylinder these carburetors should be set on a special dual or triple manifold, whichever the case may be, that will have no constricting passageways for the fuel. The manifold must be large enough to handle the capacity of fuel needed by the engine. The cost of a dual manifold is in the neighborhood of $40 to $60. If this seems a little heavy on the green stuff there are "Y" adapters on the market for only $12.50. The "Y" adaptor allows the use of dual carburetion on a stock manifold with only about 10% loss in engine efficiency over the costlier manifolds.

The addition of the dual carburetors can add another 10 horsepower, increase top speeds, give better pick-up, and greater pulling power when they are bonneted with race-type air cleaners. These will allow the maximum in air volume and filtering with the minimum of dirt, dust, and engine choking. This addition of several carbs does not necessarily mean twice as much fuel consumption and lower mileage to the gallon; rather there will be better mileage in store because the engine will be getting full power from the fuel it burns and therefore go farther.

Another method of getting more fuel and air into the engine on the intake stroke is the use of a super charger, or blower as it's commonly called. The

supercharged mounts on the engine between the carbuetor and the motor. It sucks fuel and air through the carburetor and distributes the mixture under pressure to each of the cylinders. In effect, this greatly increases the amount of air and fuel in the mixture charge which in turn increases the punch, upon being ignited. In actual tests the addition of a supercharged increased the horsepower of a stock Ford V-8 as much as 30 per cent. In the past the cost of a supercharger has been too great, but recently McCulloch Motors of Los Angeles has come out with a noiseless, centrifugal type blower that is well within the grasp of the average enthusiast. And surprisingly enough it can be used throughout the range of modern automobile engines!

Now that we have paved the way for the greatest fuel mixture we must provide a quick, easy exit for the exhaust gases. The stock exhaust system has been very well termed by one writer as "an abortion fit only for the junk pile." Nothing constipates the engine more than the sharp bends and baffle plate mufflers that Detroit puts out. The back pressure holds back much of the exhaust gases which dilutes the fuel mixture charge and cuts down efficiency. This problem is easily solved. Even Detroit is beginning to realize the advantages of a dual exhaust system. Cadillac has had them for several years and now they may be had on nearly all cars as an extra in their power kits. There are many makes of dual exhaust setups which when combined with low pressure straight-thru mufflers give very little back pressure and produce a deep, mellow tone. Engineers show there is a gain of about one horsepower for each half-inch reduction of back pressure on the motor which gives us an additional 4 to 8 horsepower.

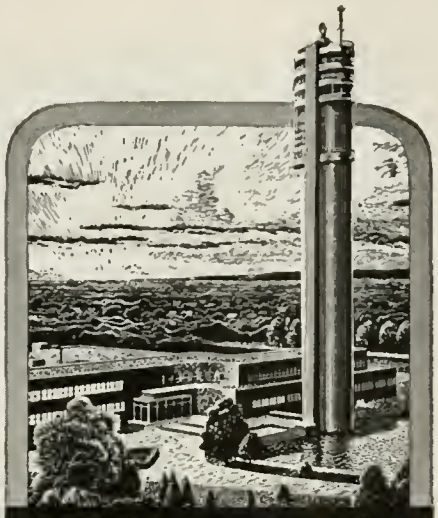
Our final step is one that will not necessarily add any horsepower but it can certainly steal the power if it is not kept up. This is the engine's spark of life—the ignition system. It's function seems to be the fairly simple task of igniting the fuel mixture in the combustion chambers. There's a little more to it than that. The battery provides the current but it doesn't have the oomph to jump such a spark on its own; so it is hooked up to a coil which steps the 6 volts up to as many as 30,000 volts. Of course, the spark has to be at the right cylinder at the right time. For this purpose we have a distributor consisting of breaker points, a condenser, and a rotor, which rotates to make contact with each plug in firing order. Each time the breaker points close a surge of juice from the battery builds up a magnetic field. When the points open the field collapses and a high tension surge produced in the coil travels to the rotor from which it jumps to the spark plugs in proper firing order. Each time the points open and close, the rotor rotates to make contact with a different plug. This process occurs about 10,000 times per mile.

Especially on a souped engine the ignition system must be at peak efficiency all the time. With the greater compression increasing the density of the gas mixture it takes a stronger spark to bridge the gap between the spark plug electrodes. Here, the best solution is a dual ignition system—two coils and two sets of breaker points. This would divide the 8-cylinder engine into two systems of four cylinders each, which would double the time allowed to build up the voltage for each spark and greatly reduce the wear on the individual parts. Also the spark plugs must not be forgotten. Under the extreme pressures in the combustion chamber the spark plug's center electrode tends to heat up resulting in premature detonation of the fuel mixture. To prevent this loss in power, spark plugs of the proper heat range must be selected according to the dictates of the individual engine. Generally speaking, a slightly colder plug is usually used on hot engines.

Although the five steps just mentioned are, I think, the basic steps in soup-up operations, there are still many things that may be done to the engine. We can gain about 5 horsepower by porting and relieving, which consists of enlarging the diameter of the intake ports and grinding away some of the block between the valve ports and the cylinders, allowing the engine to breathe better. The cylinders themselves can be overbored up to 0.120 inches, giving more cubic inches of fuel to the cylinder which, in turn, produces approximately 20 more horsepower. Naturally, overboring means we must switch to oversize racing pistons which are designed to operate at the higher compression ratios. We may now add more cubic inches and an additional 10 horsepower by stroking, which merely means increasing the length of travel of the piston within the cylinder.

If we have come this far we should now balance the engine. In a hopped-up motor with its extra horses and higher rpm, every ounce of weight that is off-balance becomes pounds of fury with but one thought—to tear the engine apart. By grinding off superflous metal from the pistons and cam rods we can balance the engine, which would remove all vibration and double the engine's life.

Now that we've gone all out on the engine there still remains the transmission and rear end gears. With a more powerful engine we may use higher gear



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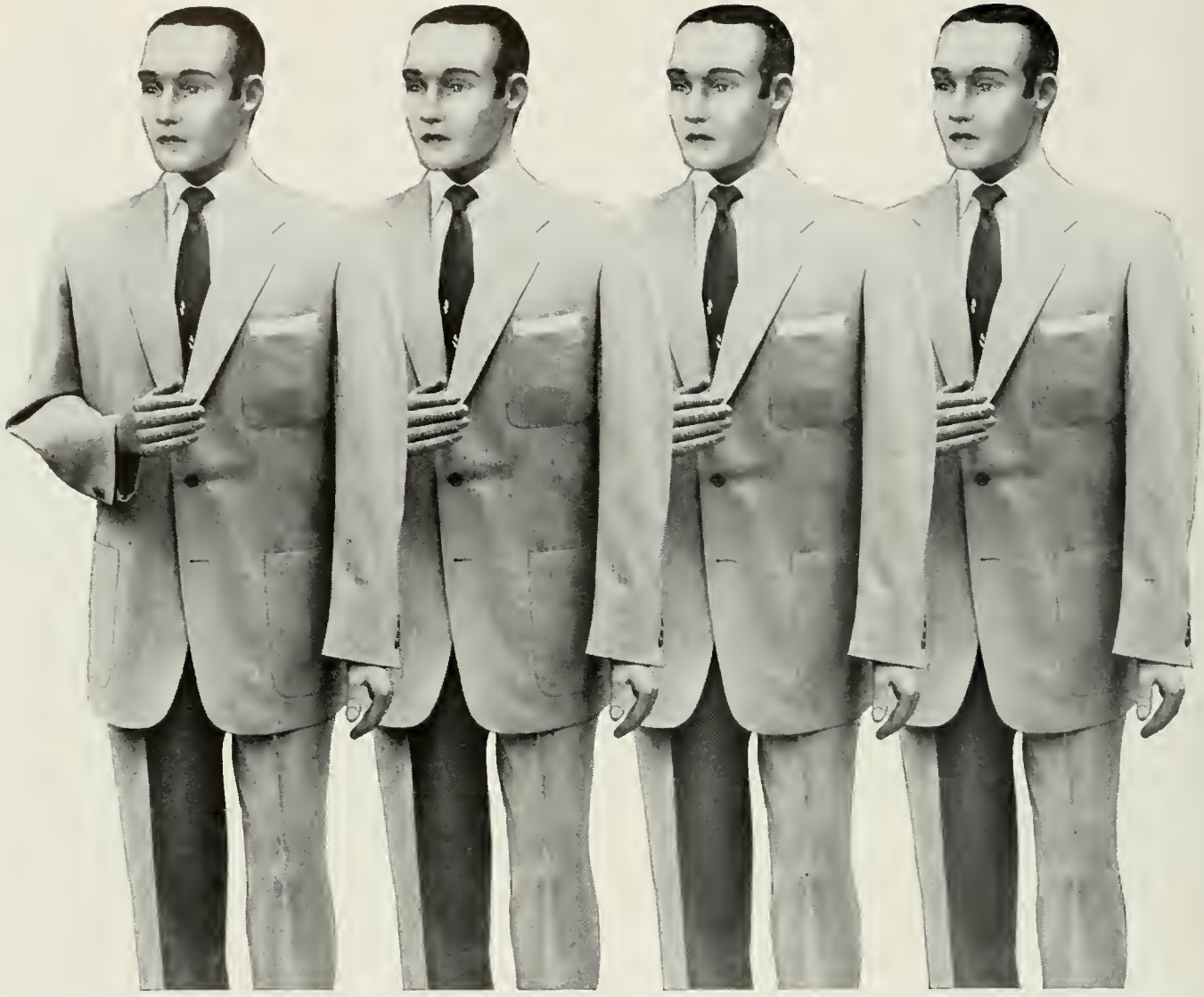

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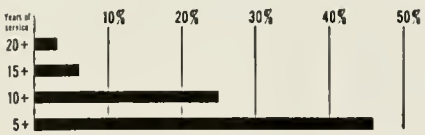

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ratios. Generally speaking, higher rear end ratio gives higher top speeds, and higher transmission ratios produce faster acceleration. Both changes will give greater economy because the car goes farther on one engine revolution. A set of Lincoln Zephyr gears in the transmission will give better jump at the stoplight, and if we switch to larger gears in the rear end we'll have more go at the top end. In fact, the engine will be winding itself out with gears that are holding it back if the stock rear end isn't replaced with a higher ratio. About the best choice for city driving would be 4.11 1 or 3.78 1 gears with best gas mileage around town. A cheaper and very common practice is to replace the rear tires with larger ones. Just switching from 6.50x16 to a 7.00x16 tire will produce a gain of about 4 to 5 mph.

Well, the rod goes now but will it go safely and stop safely? No one wants to be flying along in the 100 mph-plus range and suddenly have a threadbare tire give out. The tires must be in top condition with plenty of rubber at recommended pressure because if the baby's shoes wear out, what's she going to walk on.

Even with the best shoes they have to have shocks that will keep them planted firmly on the ground. Poor shocks will bounce the car up and down like crazy, making control very hard to keep. The best type shocks are probably the tubular hydraulics with double-acting action. This means they will dampen the spring action on the way up as well as on the way down. After the shocks are mounted in a slightly-angled vertical position they should be checked regularly for leaks, worn mountings, etc. The shocks may be checked by bouncing up and down on each corner of the car. If the car continues to bounce after the pressure's taken off, there's something wrong with the shock on that corner and it should be looked into.

Although we have good tires properly suspended, we want to be sure we can stop on a dime if the need arises. Bugatti, maker of the world famous sports car of the same name, once said, "We make our cars to go, not to stop." That sounds like a pretty good policy until we suddenly see that bridge ahead is washed out. Not being able to swim, we want to stop! This is best accomplished with well-adjusted hydraulic brakes. Hydraulic brakes, which work on the Pascal principle (confined liquids transmit pressure equally in all directions without loss), should be used to replace the mechanical brakes on all pre-1938 cars. Hydraulic brakes eliminate the constant adjustment needed by the obsolete mechanical ones. But the flexible hose connections should always be kept in good shape, the fluid kept at the proper level, and the brake linings adjusted. As the brake linings wear down, they must be adjusted nearer to the drums to compensate for the wear.

Possibly there are a couple of other safety features that should be mentioned here. Safety belts are becoming increasingly popular through articles telling how statistics prove that is safer to ride an accident out with the car. Flying through the windshield or being plastered against the dash is definitely not recommended. For approximately $10.00 this can be virtually eliminated with the installation of aircraft-type safety belts. To be safe safety belts they should be bolted to the frame and have a simple release buckle. The belts can even be purchased in colors that will harmonize with the car's interior.

The other safety feature is localizing and extinguishing a fire, should one occur. Undoubtedly, one of the hottest spots to be caught in is in a rod that is on fire. This usually occurs from a defect or sudden break in the fuel system. The best protection is to have a metal firewall between the driver compartment and the engine. The fuel for the fire can be cut off by a shut-off valve on the dash. This shuts off the flow of fuel to the engine and all that's needed then is a good fire extinguisher to put the fire out. The fire extinguisher, itself, may be mounted beneath the dash for easy access. As the old and true safety slogan goes, "The life you save may be your own." So why not?

Now that we have a car that goes and stops faster and safer, let's see if we can't improve upon the exterior appearance. Lowering the body gives us better driving and handling characteristics as well as that long, low, ground-hugging look. The main thing to guard against is excessive lowering which clearly invites bumper dragging and banged-up exhausts while driving over rough roads or up inclined driveways. Also if the back end is lowered the front end should also be lowered to prevent a tail heavy appearance which actually harms handling characteristics.

There are three basic ways to attack the lowering problem—altering the suspension, lowering the chassis, channeling the body. Altering the suspension, though not the best method, is probably the most practiced and certainly the cheapest. Fords, from '32 to '48, have transverse leaf springs which are easily lowered by installing long spring shackles. The shackles come in lengths up to 6 inches which, when used, lower the body the same amount. When the shackles are used there is a tendency for the car to sway from side to side. This is prevented by the installation of anti-sway bars which may be obtained at most speed shops. The anti-sway bar is stock on post-war Fords.

Later model Fords and other makes of cars have their springs mounted parallel to the frame. Here the problem of lowering is solved with the use of lowering blocks. The springs are attached to small pads under the axle by use of U-bolts. By replacing these pads with larger ones and longer U-bolts we can lower the car a subsequent amount. On late model cars this takes care of the rear end, but the coil springs on the front end pose a different problem. Some enthusiasts torch their springs to bend and shorten them. But the best method is probably to add an extension to the outer end of the lower A-arm and raising the inner end of the upper A-arm. The two A-arms will have the same relationship to each other and the car will be lowered by about 3 inches in the front. The necessary equipment for this lowering job may be purchased in kit form for $37.50. The lowering blocks for the rear would run about $3 to $4.

Probably the best method is to lower the chassis. And the best method of lowering the chassis is to "Z" the frame. This may be done by increasing the curve of the frame rails over the rear axle (cutting notches out of the frame, then bending up and over the notched points), or by cutting through the frame at 90° back near the axle, then lowering the front part of the rails the amount wanted and welding in reinforcing plates at the top and bottom to make the joint a single unit. These processes can lower the car about 5 inches in the rear; and then a dropped, or "dago," axle may be purchased for the front end from most speed shops, or the previously described method of lowering the front end may be used.

Channeling is slightly more expensive and more complicated. The cost is around $600 and it involves removing the entire floor section; then the body is dropped down around the frame; and the floor section is rewelded in a higher position and possibly the fenders will have to be raised to allow proper turning of the wheels. New supporting brackets usually have to be welded to the frame to properly secure the body. This method reduces the height of the body without lowering the chassis, thereby maintaining good ground clearance.

If the car has been lowered and the overall height still seems too great, as is often the case with older model cars, the thing to do is chop the top. This consists of cutting a section out of the top all around the window line, dropping the top, and rejoining it to the body. It sounds pretty simple but it is really a more complicated job than should be handled by the novice. The top doesn't always fit just right and usually requires some tricky patching,

hammering, and welding to get a decent looking job. It's almost like taking a section out of a cone and trying to get the top to fit properly onto the bottom part. Therefore, a price of $400 for a late model car top chopping should not appear too surprising.

Another method of lowering the overall height is to section the body. It is similar to top chopping but much more complicated and consequently twice as expensive. A strip is cut from around the middle of the car body, and then the top half is lowered to be welded to the bottom half. It is easily seen that this is extremely more intricate because of the many body contours you have to place your cut around. Because of the great expense this is a practice seen only on the most radical customs.

And now to de-chrome our car. Dechroming is probably the most seen customizing trick because it is rather inexpensive, and does change the appearance of the car considerably while retaining its basic good lines. The hood is the first thing we see, so naturally it would be the first item to de-garbage. The emblem, hood ornament, and chrome stripping is removed and the holes are brazed in, smoothed, and primed for about $20. If it is something such as a late model Ford with a center molding, the hood will probably have to be peaked which would make the price $50 more.

However, these processes are fairly simple and most enthusiasts who can use a welding torch may accomplish these tasks themselves. The holes that would remain when the side chrome strips are removed are easily filled in and the price of about 75c per hole is saved. Likewise the removal of all exterior chrome from the rear deck may be done by the individual. This involves the removal of the trunk handle and possibly license plate light and bracket.

When this shaving operation is completed we must find a way of opening the deck. Of the various possibilities the cable catch (like the hood release) is the least expensive. When the driver pulls a cable the trunk catch is released. Slightly more expensive is the electric solenoid catch. A solenoid is connected by a cable to the trunk latch and wired to a button on the dash. The dash button trips the electric solenoid which opens the trunk latch. Installation costs about $25.

An electric solenoid can be used to open the doors and roll the windows if the handles are removed. This operation works in the same way as the trunk solenoid catch. The buttons may be placed on the dash inside or on the inside of the door, itself. The outside buttons may be concealed in the chrome stripping and are of the type that may be made inoperative with a door key. Or they might be placed beneath the door and actuated by pressing with the foot. The price of these installations would be in the neighborhood of $75 for either the doors or the windows and they may be purchased in kit form from most speed shops.

After these major operations there remains but a few steps to complete before painting the car. The headlights may be frenched to enhance the picture of the front end. Whether the flush rim style or the recessed style is used depends upon whether the car is wanted to appear longer or shorter. The chrome rims on the headlights are brazed to the fenders. These are smoothed to appear as one continuous line and the adjustment of the light is then controlled from beneath the fender. Frenching serves to make the fender line longer, higher and more racy.

Much the same effect may be achieved in the rear by frenching the tail-lights or replacing them with different tail light lenses or units. A popular tail light unit that can be fitted into many panels without too much alteration is the late model Pontiac. Many enthusiasts have molded Cadillac fins on the rear. This operation costs $100 a side complete and is very effective on cars whose natural fender line is much the same as the Cadillac's. On cars whose natural fender line does not conform to Cadillac's the price would be slightly higher.

The front end treatment can be completed by installing a different grille. Sometimes a complete strock grille assembly from another make car can be fitted very easily. If this is not the case or not what is desired, straight grille bar kits may be purchased from most speed shops for about $30. Even a specially designed grille is not too expensive. A one-of-a-kind custom grille may be designed and constructed by the individual. Tubing or bar stock can be shaped and bent into the chosen design and then chromed before installation.

If we have all the body work completed we are now ready for the finishing touch to the exterior. A cheap paint job should not even be considered because it is the paint job that most reflects on the owner. The only choice lies between enamel or lacquer. An enamel job costs about $75. Lacquer runs about twice as much but involves much more work. Lacquer is the choice of most custom owners because of its greater depth and luminosity. A good lacquer paint job consists of about 12 coats with each coat being rubbed to a smooth surface before the application of the next. Another reason for the choice of lacquer over enamel is that lacquer may be chosen in either clear or metallic surfaces while enamel may be chosen only for texture.

The final aspect of customizing that will be covered is the interior! Much of the interior treatment is done to the dash. The simplest change is to paint the dash to match the exterior finish. They may be painted in one complimentary color or they may be two-toned. Two tones should definitely be considered if there is a natural division in the dash. The possibility is even there for half color and half chrome. Chrome should only be considered for the bottom half, however, because a heavily polished top section would reflect the sun's rays like a mirror and could be very annoying.

Another change that might be included in the dash treatment is replacing the stock instruments with different or newer ones. Many accessory gauges might be added like a tachometer and a Perfometer (a meter which registers performance in such ways as acceleration, pulling power, hill climbing ability). The knobs on the dash, the door knobs, and the gear shift knob may be painted, chromed, or, many enthusiasts are doing now, the knobs might be made of lucite plastic. They may be one color or they may be composed of 3 or 4 slabs of different colored plastic. The effect is very striking!

And now for the final task—custom upholstery. The most popular is the pleat and roll, but there is no limit to the design one may choose. The upholstery should be chosen to compliment the exterior finish of the car and is usually of two contrasting or complimentary colors, itself. The expense of leather usually leads to the choice of Naugahyde as the material to be used. After the seats are carefully inspected the upholstery is fitted in the chosen design over generous layers of foam rubber.

Sooner or later we'll be waiting to upholster the rest of the interior, so we may as well do it now. We do the door panels, kick panels, and side panels in a design matching that of the seats. The headlining is usually done in a solid tone with contrasting beading running across every so often. Custom floor mats are of a heavy duty, first quality rug material. It should be of a darker color that will not show the dirt too easily. Small 9x9 colored rubber mats may be placed on each side to protect the rug, especially on a muddy day.

At last the car's finished! All that remains is to fill the gas tank, turn the key in the ignition, and sink back into the foam rubber as the little jewel bites into the pavement and blasts off, the duals emitting their mellow warning to all would-be challengers.

Thanks to:
1. Fawcett Publications.
2. Quinn Publications.
3. Trend Books, Inc.

Allison Engineers Pioneer Turbo-Prop Development

YC-130

YC-131C

William J. Layne received his B.S. in Aeronautical Engineering from Purdue University in 1950. Before joining the Allison engineering staff, he served as a captain in the Air Force 1942-46 and 1951-53. Bill, now a Flight Test Engineer, is shown taking gas turbine compressor readings from the equipment used to start turbo-prop engines at the Allison Test Facility in Indianapolis.

Allison is out in front, leading all U.S. aircraft engine manufacturers with more turbo-prop flight experience than has been accumulated by all of the nation's other engine manufacturers combined.

That's because Allison—working closely with the military—was a pioneer in the design, development and production of both engines and propellers for turbo-prop aircraft. First flight with an Allison turbo-prop engine was made in a Boeing B-17G at Indianapolis in 1949. Today, eight different types of military aircraft—including the VTO's—are making history with the Allison Turbo-Prop.

The Allison Turbo-Liner, shown above, was America's first turbine-powered, commercial-type transport. This flying test bed, which is a Convair 240 converted to Allison Turbo-Prop engines and Aeroproducts propellers, was the forerunner of modern military transports such as the Lockheed C-130 and the Convair YC-131C. After its first flight in 1950, the Turbo-Liner was used primarily as an engineering flight test aircraft, checking out problems for military application. More recently, the Turbo-Liner has been used on demonstration flights to show the many advantages of a turbo-prop powered transport. To date, the Turbo-Liner has made nearly 700 flights and has accumulated nearly 500 hours of flight time.

Now available for commercial application, Allison Turbo-Prop engines and their matching Aeroproducts propellers today are setting new standards for transport aircraft in speed, load-carrying ability, and economical operations.

Looking ahead, with our extensive development and expansion program, we need more engineers to carry on in a field where you'll find unlimited opportunity. We have immediate openings for the well-qualified, technically-trained, young graduate who is interested in starting his engineering career with a recognized leader in the industry. Allison representatives are interviewing prospective June graduates now. Write for further information: R. G. Greenwood, Engineering College Contact, Allison Division of General Motors, Indianapolis 6, Indiana.

GM AIRCRAFT POWER

Allison DIVISION, GENERAL MOTORS CORPORATION, Indianapolis, Ind.

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Jerry Loucks asks:

What sort of work would I do on my first assignment with Du Pont?

R. GERALD LOUCKS is currently working toward his M.S. in Chemical Engineering at Carnegie Institute of Technology. Jerry has served as president of his student chapter of A. I. Ch. E. and participated in intramural sports—besides finding time to play the trumpet in the R.O.T.C. and Kiltie bands. Right now, Jerry is giving a lot of thought to the selection of an employer.

CHARLES W. LOUNSBURY, Jr., worked at Du Pont's Chambers Works for three summers before he received his B.S. in Chemical Engineering from Rensselaer Poly. Inst. in 1940. Since then he has taken an M.S. from Carnegie Tech., and has been continuously employed on interesting assignments at various Du Pont plants. Today Charlie Lounsbury is Technical Superintendent of the Grasselli, N. J., plant of Du Pont's Grasselli Chemicals Department.

Charlie Lounsbury answers:

There is a great variety of first assignments at Du Pont, Jerry, depending on a man's field of training and the general area of work he has selected. For example, I understand you're interested in plastics, and you might start in *development work* on plastics, as I did. I worked with a team of more experienced engineers to increase the capacity of equipment used in producing "Lucite" acrylic molding powder. This was a natural prelude to my next major assignment, where I acted as a liaison between Du Pont's *Design Division* and the plant group—on the design of a new plant for making another form of "Lucite" plastic.

Or take *research work*. Here a new man is generally assigned to minor research problems until he becomes familiar with the general features and requirements of an industrial research program.

A young man interested in *sales* may start in a plant or laboratory dealing with the products he will later sell; or he may join a group of trainees to learn selling techniques right from the start.

A man aiming for *production supervision* may first spend a year or so in laboratory or plant development work. Or he may start as an operator—in a plant producing nylon or "Dacron" polyester fiber, for example. In this way he obtains firsthand knowledge of his process, and establishes a bond of mutual respect with the men he'll be working with on his major assignments later.

In general, Jerry, a man is chosen for a specific job within the scope of his major field of study. His first assignment is intended to help him make the best use of his abilities as promptly as possible.

WANT TO KNOW MORE about working with Du Pont? Send for a free copy of "Chemical Engineers at Du Pont," a booklet that tells you about pioneering work being done in chemical engineering—in research, process development, production and sales. Write to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Building, Wilmington, Del.

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BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*
WATCH "CAVALCADE OF AMERICA" ON TELEVISION

From a Tee-Pee to a a Two o'clock

by Dave Templeton, '56

Note to Reader: This story is entirely fictitious. Anyone who knows the author knows he would have to work hard to even swing a deal for a pair of second hand roller skates, much less a Mercedes.

The weather was fine that day. It was Spring and I still had a few hours before I had to get to my two o'clock class. So, I packed a few sandwiches and jumped into my Mercedes and zoomed out of Champaign-Urbana. I'm used to driving the highways around here, so I decided to try the first dirt road I came to. Throwing my little baby into second, I made a right turn, up over a rise and down into a gully and then over a bridge. (I suspected the little river was feeding into the mighty Bone Yard Creek.) I'm not a wild nature lover, but I had to admit that the day was great. Riding along under the trees and along side the bushes was putting me into a class cutting mood when a little figure jumped out into the road. When I was almost on top of him, I realized it was that little Indian I had met last year, Chief Tech-i-engi-graph. (Chief Tech will have to suffice since it gave the printer trouble fitting such a long name onto the page.) Even though I had met him before, I still found it hard to believe that this was a genuine Indian talking.

"Hi there, Dave. Say, that's a cool crate you got there, man." See what I mean. And he's an Illini Indian, at that.

"Yeah," I smilingly answered. "It's a little something I picked up on a wild spur of the moment." I hoped he didn't notice my right wrist where the auto dealer had cut, extracting my last payment. "Hop in. Give you a buzz in it." I had come to like this little character and I knew that a ride in a sports car would really give him a thrill.

"Swell," he said, opening the door. "I was just about to ask you if you could give me a lift to town, Dad."

Well, to say the least, this little guy had really gotten jazzed up in his lingo. I figured it must have been the influence of being in a sports car. He was obviously getting a big charge out of the whole thing: sitting in the seat, feeling the upholstery, smiling to himself and his feather flapping in the breeze.

"How much this cost you, Dave."

"The down-payment wasn't bad. Why? You interested in getting one?" I tried to hide my pity for this poor little fellow.

"No, no, I just wondered. It's real cool, man; there should be one in every tee-pee I always say."

"Definitely," I said with as much conviction as I could. "Are you a sports car fan?" Being a fan myself, this was a subject dear to my heart. My only fear was that it wasn't a topic my little Illini friend didn't delve in. Just by looking at him . . . his little buckskin pants, the loin cloth over it, and his little feather which must have been won in combat with some lady's Shaparelli hat a football game in Memorial Stadium, I assumed he wasn't too well off. He was a brave little fellow, indeed.

"Oh, I look them over now and then," he answered casually.

"How do you get around in these sticks? Do you have a pinto?"

He threw me a look that cracked the left lens of my glasses. "Come off it, Dad. The era of horses for Indians has passed. Haven't you seen me around campus in my . . ."

"Say, there's the highway," I hastily cut him off. I didn't want him to feel ashamed telling me how he got around. He was undoubtedly going to tell me about his wagon or something along those lines.

"Great! When we hit that pavement and if there aren't any cars on the road, open it up a little bit." I looked at him. He had sense. He would make a good driver some day. He had the makings of one . . . saying, "open it up a little," and "if there aren't any cars on the road." Those two statements make the difference between a crazy, mixed up driver and a good one. I got onto the highway and we were driving along when another sports car was approaching. "Cow there's a . . ."

". . . Lancia," he interrupted.

"Hey. That's right. How did you know?"

"Don't be so naive. I think you've got us still pegged for tee-pees, horses, and totum poles."

"You mean you don't have those anymore?"

"Only when the tourists come around. But the tee-pees are prefabs even then."

"Oh," I answered in my most worldly manner. I always liked uttering profundities such as that.

"Gad! You must have a real good group on the campus. That was an Allard and a Guthrod that just went by weren't they?"

"Yes," I gulped. I had hoped my surprise over his knowledge of foreign cars was not too noticeable. After rolling my tongue up (which had fallen into my lap) and neatly placing back into my mouth, I continued my sparkling conversation.

"Yes," (I was picking up where I had left off). "Say, you seem to know your cars, don't you?"

"Oh, I get around," he said easily, putting his moccas'ned foot up on the dashboard. We had just passed the outskirts of Champaign-Urbana and were moving toward Green Street.

"Any place in particular you'd like to go?"

"Yeah, make a left turn two blocks down and go over about three. This I did, being careful not to ruin the crease in the pants of the policeman who I ran over at the intersection.

The place where he wanted me to stop was coming nearer. I felt a pang of sympathy for this little Chief Tech. "Well," I said trying to hide my emotion and turning on the defroster to my glasses, drying the tears which were starting to trickle down my cheek. "I guess this just about ends your ride in my car. I hope you'll get another chance to ride in one someday . . . whether it's mine or someone else's."

"Oh, don't take it too hard, Dave. Here. This is where I want to get out." We stopped in front of a gas station."

"This is where you want to go?" I asked.

"Yeah. Well, thanks a lot, Dad. It's been a real pleasure riding in a Mercedes for a change."

"For a change?" I asked. But he didn't hear me. He had gone inside. Just as I was about to pull away, the door to the garage part of the service station rolled up. A Jaguar roared out and pulled up alongside of me.

"Well, here's hoping we run into each other again, Dave. Figuratively, of course." With that little Chief Tech zoomed off.

It took a little while to get my composure back again. Not that I was amazed by all this, but I didn't take my car out of first all the way to my two o'clock tee-pee . . . er class.

One day in November, the wife of a factory efficiency expert asked her young son what he wanted for a Christmas present.

"A little baby brother," he said.

The mother stammered a bit, then managed to protest, "There's too little time."

To which the boy asked innocently, "Couldn't you put more men on the job?"

* * *

A father and his young son, who carefully held in his lap a shoe box punctured with air holes, were seated in a bus. When the bus stopped for a red light, the lad was heard to ask, "Daddy, is my kitten a man kitten or a lady kitten?"

"A man kitten," said the father promptly.

"How do you know," the boy continued.

Every passenger within earshot waited expectantly for the reply.

"Well," explained the father, "he's got whiskers, hasn't he?"

* * *

The professor signed his name on the blackboard and followed it with B.S., M.S., and Ph.D.

A freshman leaned over to his neighbor and asked him the meaning of the letters.

"Well, you know what B.S. means, don't you?"

"Sure."

"Then, M.S. means more of the same and Ph.D. means piled higher and deeper."

* * *

Did you ever note how often a narrow mind and a wide mouth go together?

* * *

We understand that manufacturers of certain feminine garments are currently making only three kinds: The Russian type, the Salvation Army type and the American type.

The function of the Russian type is to uplift the masses.

The function of the Salvation Army type is to raise the fallen.

The function of the American type is to make mountains out of mole hills.

* * *

One reason the football season is such a popular time of the year is because it is the only time a man can walk down the street with a blonde on one arm and a blanket over the other and not encounter raised eyebrows.

* * *

Salesman: "Sir, I have something here that's guaranteed to make you the life of the party, allow you to win friends and influence people, help you forge ahead in the business world, and in general make life a more pleasant place and invigorating experience."

Engineer: "I'll take a quart."

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Photograph above: Engineer writer John Burnett (left) works with engineers John H. Haughawout (right) and Donald King to compile handbook information.

Bendix JET IGNITION

THE tough job of lighting a match in a tornado will give you some idea of the problem of firing a jet engine on the ground. Even more difficult is refiring the engine in flight should a flame-out occur—especially at high altitude.

Up there you not only have to reckon with low-volatility fuel but with rarefied air rushing through your engine at super-hurricane speed. Here, you can be certain, is a mixture that violently resists igniting!

Our Scintilla division at Sidney, N.Y., developed a special ignition system with the answer: a super-spark hot enough to fry a rock and of sufficient duration to fire and refire jet engines quickly. It has worked so successfully that, today, Bendix-Scintilla† Jet Ignition Systems have been selected as standard equipment by most of the leading jet engine manufacturers.

Nation's Foremost Source

Bendix-Scintilla is known to engine people everywhere as the nation's top source of supply for ignition equipment. Most military planes rely on our ignition, and we doubt if you can ride on a commercial airliner that isn't sparked by Bendix-Scintilla. Your power lawn mower farm or garden tractor or outboard motor may have one of our many types of magnetos developed for such applications. Leading automotive manufacturers experimenting with turbojet engines in passenger cars, trucks and buses are using Bendix-Scintilla Jet Ignition.

Continual research and years of practical field operation have fitted us to anticipate and solve ignition problems; and that's why engine manufacturers, seeking advice, talk to Bendix-Scintilla people.

ights matches in man-made tornadoes!

This chapter is part of the over-all story of Bendix viation Corporation, a story of successful work in develop- ıg and making nearly a thousand different products for ores of basic industries. No doubt some of our products can ontribute to your business by improv- ıg your operation and cutting costs. Vhy not write on your company letter- ead for the interesting digest "Bendix nd Your Business."

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ANALYZE YOUR CAKE AND KEEP IT TOO – WITH X-RAY

by Vern W. Palen

Research & Control Instruments Division North American Philips Co., Inc.

In these days of tough competition when manufacturers are striving to turn out new and improved products, it becomes increasingly important to know as much as possible about materials.

Undoubtedly, there are vexing problems in your laboratory and shop that defy solution or are costly by ordinary methods. You may have questions which involve identification and measurement of elements and constitutents of compounds that should be answered. Perhaps there are some unsolved mysteries in your plant processes that need clarification.

X-rays can do these jobs for you without harm to your specimens. If your laboratory studies and production control problems are chiefly concerned with compounds and the atomic structure of materials, *you need the X-Ray Diffractometer.* When your investigations merely deal with elements present in a substance, *then get yourself an X-ray Spectograph.*

Specimen preparation is relatively easy. The usual precautions must be taken, of course, to be sure that is truly representative of the lot from which it is selected. In some cases, the specimen will be powdered and seived. In other instances, it need only have its surface polished. Most important, it will come back to you unharmed after the analysis, a point of extreme importance when dealing with rare or costly materials.

Once the specimen is ready and is inserted in the X-ray Diffractometer or the X-ray Spectograph, the instrument takes over in semi-automatic fashion. The operator merely sets the controls to obtain the desired results, then waits for the answer, usually in the form of a strip-chart on which a hill-and-valley curve is recorded.

For production control the chart may not be needed. For example, where one wishes only to check presence or absence of specific elements or other constituents, the instruments can be set up to give rapid visual answers. In such cases, preliminary laboratory chart investigations are the basis for later shop procedures.

Fig. 1 shows the essential components of the X-ray Diffratometer and X-ray Spectograph. It will be noted that the two instruments are very much alike, except that the Spectograph has an *analyzing crystal.*

Whereas the Diffractometer detects and records all rays diffracted from the specimen, the Spectograph "screens" some of the rays before they reach the Geiger counter. The crystal acts as a diffraction grating, resolving and dispersing the various wavelengths like an optical grating handles visible and ultra violet radiation in the optical spectograph.

Long wavelengths of X-radiation are dispersed to higher angles and the shorter wavelengths to lower angles. The crystal separates the various wavelengths sufficiently that each may be individually detected and intensity can be measured.

Since the intensity of the characteristic radiation from a given element is proportional to the percentage of the element present in the specimen, the intensity as measured by the Geiger counter may be used in quantitative analysis.

Fig. 2 shows a complete Diffractometer and Spectograph installation. The wide-range goniometer is shown (left) in operating position on the table top of the X-ray generator. These two units plus the electronic circuit panel (right) are components of the Diffractometer.

The Spectograph uses the same X-ray generator and electronic circuit panel in conjunction with the special X-ray tube and goniometer assembly shown on the center cabinet. Unitized design minimizes equipment investment since it permits double usage of the major components.

When an analysis is completed on either of the two X-ray instruments, the result is a strip-chart showing a hill-and-valley curve. Fig. 3 shows a typical Diffractometer chart.

To convert this information into useful terms, certain reference data must be available. Books and card file systems can be obtained which list angular locations and intensities of X-ray lines for thousands of chemical and metallic substances.

The chart of Fig. 3 is for quartz and the three highest peaks occur at 26.58°, 20.90°, and 50.10° (two theta). From a handbook, these angles are interpreted to mean equivalent atomic lattice spac-

Complete installation of X-ray Diffractometer and X-ray Spectograph. On left, X-ray generator and wide range goniometer. At center, special horizontal X-ray tube and goniometer assembly for X-ray Spectograph. On right, electronic circuit panel and strip-chart recorder.

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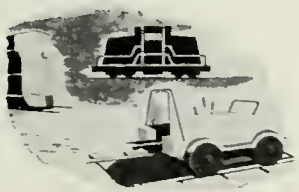
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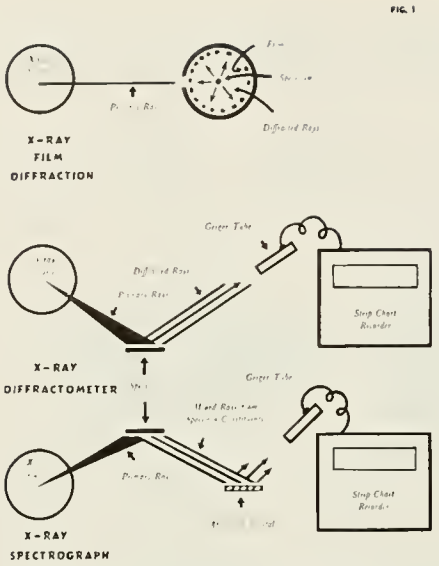


Compannents and geometrical arrongement of the X-ray diffractometer and Spectograph.

ings (d) o f3.35, 4.24 and 1.81 respectively.

For quantative work with the X-ray instruments, it is necessary to have standard specimens for comparison with the unknown. If standard specimens having known quantities of these elements are analyzed on the Spectograph, then peak heights on the charts can be related and calculations can be made for the unknown. Since most production line problems are concerned with variations in well-known specimens, the analysis procedure is frequently quite simple.

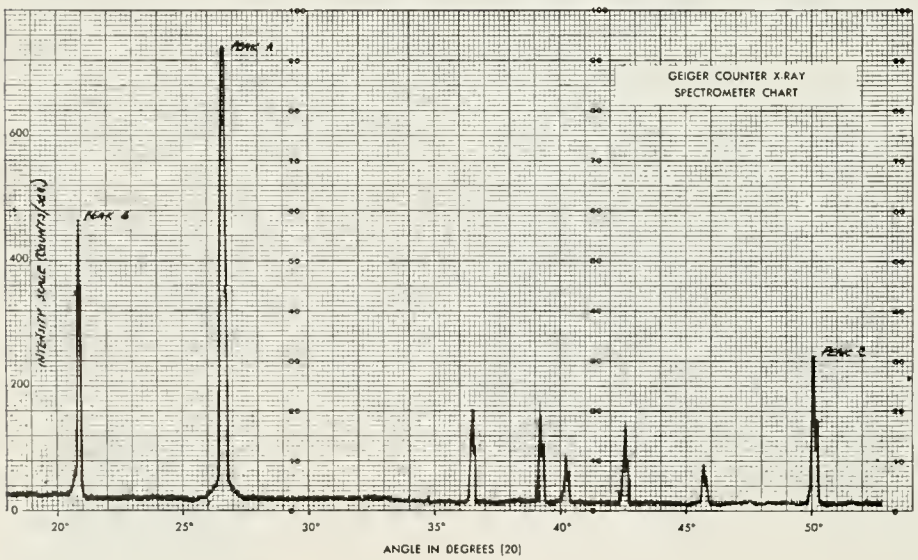
One recent new field in which X-ray analysis has been applied effectively deals with thin films. Coatings of six micrograms per square centimeter of stainless steel were readily identified on plastic base materials. In other words, the new technique easily and quickly determines percentages of chromium and nickel present in a specimen of 18-8 stainless steel where one square centimeter of the film actually contains about one microgram of chromium and less than one-half microgram of nickel.

Micro X-ray spectography techniques have distinct potentialities for evaporation control through rapid analysis of rates of deposits from solvents or through checking tiny quantities of condensate. Flash coatings, used for protective and decorative purposes, can readily be controlled as to thickness—a process heretofore extremely tedious and difficult, as well as inaccurate.

Air contamination and industrial plant flue recovery are important fields in reducing outputs of hazardous smokes, and in recovery of valuable by-products. Machine friction, a subject of great interest in aircraft, automotive and stationary engine design, is now susceptible to more efficient attack by analysis of thin films. This technique gives clues to the transfer of metals in the formation of superstrata alloys under heat and pressure. It will also reveal the degeneration o fbearing surfaces due to chemical interaction with constituents of lubricants.

In many fields of metallurgy, micro X-ray spectography will be useful in studies of molecular or atomic migration at interfaces, particularly in the case of laminated metals.

In criminal investigations, where quantities of materials are often in the microscopic realm, stains, smears, inks, friction pick-ups and ingested poisons in small amounts are potential problems for the new thin-film method.



X-ray Spectograph chart for specimen containing silver, copper, nickel, and chramium. Accurate quantitative data is abtained by comparing height of peaks for unknown with known samples.

Techno-Cutie

PEGGY ANN HOOVER is the pretty miss who adorns the pages as TECHNO-CUTIE this month. Peggy, who is 20 years old, is 5 feet, 3½ inches tall and she weighs 104 pounds. She has blonde hair, blue eyes, and for statistical minded engineers, the dimensions from top to bottom are: 34-22-34. Peggy has a host of activities on campus which leave her no spare time, the main one being the female lead in the spring musical, "Good News". As a resident of Champaign, Peggy is "Miss Champaign-Urbana", the queen of the Twin Cities. She appeared on the Horace Heidt talent show and last summer she was the lead in an opera at Tanglewood, the nationally known summer camp. Peggy resides at Alpha Omicron Pi, and she is a member of Sigma Alpha Iota, the professional music fraternity. At last word, Peggy tells us she isn't pinned, engaged, or married, so if you can find her some spare time the field is open.

According to a certain E.E., the boys over in E.E. lab have developed a new whiskey test, which runs like this:

Connect 20,000 volts D.C. across a pint of fluid. If the current jumps it, the product is poor.

If the current causes a precipitation of lye, tin, arsenic, iron slag, and alum, the whiskey is fair.

If the liquor chases the current back into the generator, it's darn good stuff.

* * *

The old engineer pulled his favorite steam engine up to the water tank and briefed the new fireman. The fireman got up on the tender and brought the spout down all right, but somehow his foot caught in the chain and he stepped into the tank.

As he floundered in the water, the engineer watched him with a jaundiced eye.

"Just fill the tank with water, Sonny," he drawled. "No need to stamp the stuff down."

* * *

Class Reunion: Mixing of old grad with Old Grandad.

A DREAM COME TRUE

by Robert J. Marks, Aero. E. '58

One of the most fantastic and expensive cars in the world today comes from one of the relatively poorer countries in the world. The country is Spain, and the car is the Pegaso.

The Pegaso is a combination of the best engineering principles that are known today. It is truly an idealistic creation for which no expense has been too great to materialize this dream car.

The engineer responsible for this magnificent piece of machinery is D. Wilfredo Ricart, formerly associated with Alfa Romeo. He is now working under the auspices of the Empresa Nacional de Autocamiones of Madrid, a company that was formed in 1946 to manufacture trucks and buses. The Pegaso is its first attempt at producing a passenger car. It is manufactured in Barcelona in what was formerly the old Hispano Suiza factory. The Hispano-Suiza is considered by many people to be the finest car produced in the post World War I era. The first new car that was turned out of there was the Pegaso Z-102, in 1953.

Since then, the Z-102 has been modified, and at the present time there are three versions offered by the factory, ranging in price from $15,000 to $35,000.

Although none of the ideas in the Pegaso represent any revolutionary departure from familiar principles, the fusion of so many delicate and expensive features is quite rare. The idea of quadruple camshafts in itself is quite staggering to the imagination. When you couple this with the fact that power output would increase steadily up to a theoretical, though unattainable, 9,000 revolutions per minute, you may have some idea of just how fine a piece of machinery this car is.

Like any other new car, the Pegaso has had some "bugs" in it and has not done anything spectacular in competition, to date. It cannot be doubted that when all the "bugs" have been eliminated, this one-ton, 150-horsepower car will eventually turn the tide in racing history.

Because of the quality of the car in conception and manufacture, the cost is understandably quite high. Although, if a car of this calibre were to be constructed in America, it would only be feasible as a million dollar experimental model, made by some Detroit manufacturer.

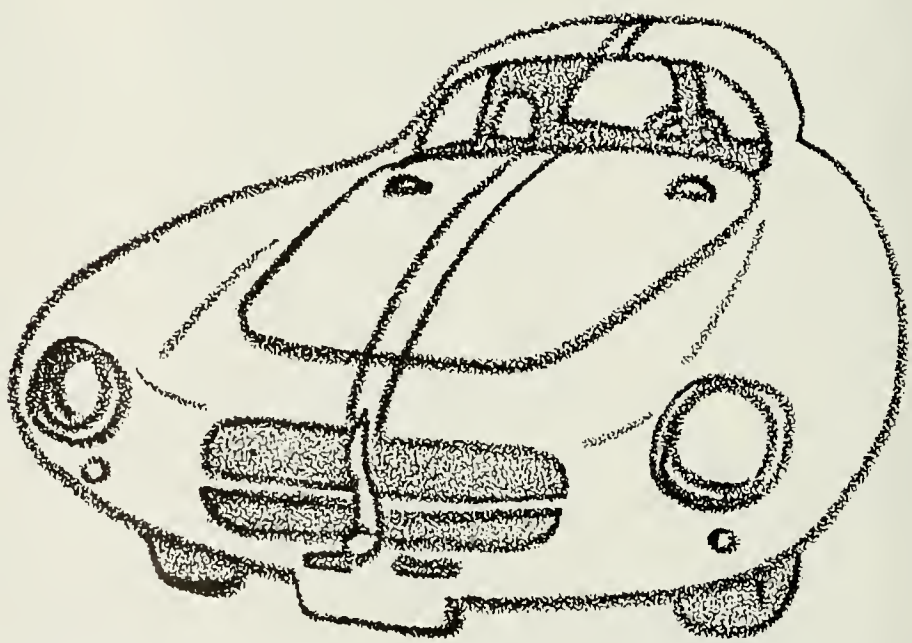
The three models now in production are a 2.8 liter (171 cubic inches) model, a supercharged 2.8 liter model, and a 3.2 liter (195 cubic inches) model that is also supercharged. The different models are so designated by their piston displacement. Body styles at the present time are five in number. They are an aerodynamically designed sports Berlineta designed by Pegaso's own styling department, a Berlineta two-to-three seater sports coupe by Touring, a two-seater hardtop convertible and a two-seater sports coupe by Saoutchik, and a radically designed semi-glass-roofed three seater by Touring that looks like something straight from a Buck Rogers adventure. The car has very appropriately been named "Thrill."

The engine design is a composite of all the accepted best features of today's reciprocating internal combustion engines. It is a 90-degree V-8 with an over-square bore and stroke, with hemispherical combustion chambers and inclined valves that are actuated by a pair of overhead camshafts for each bank.

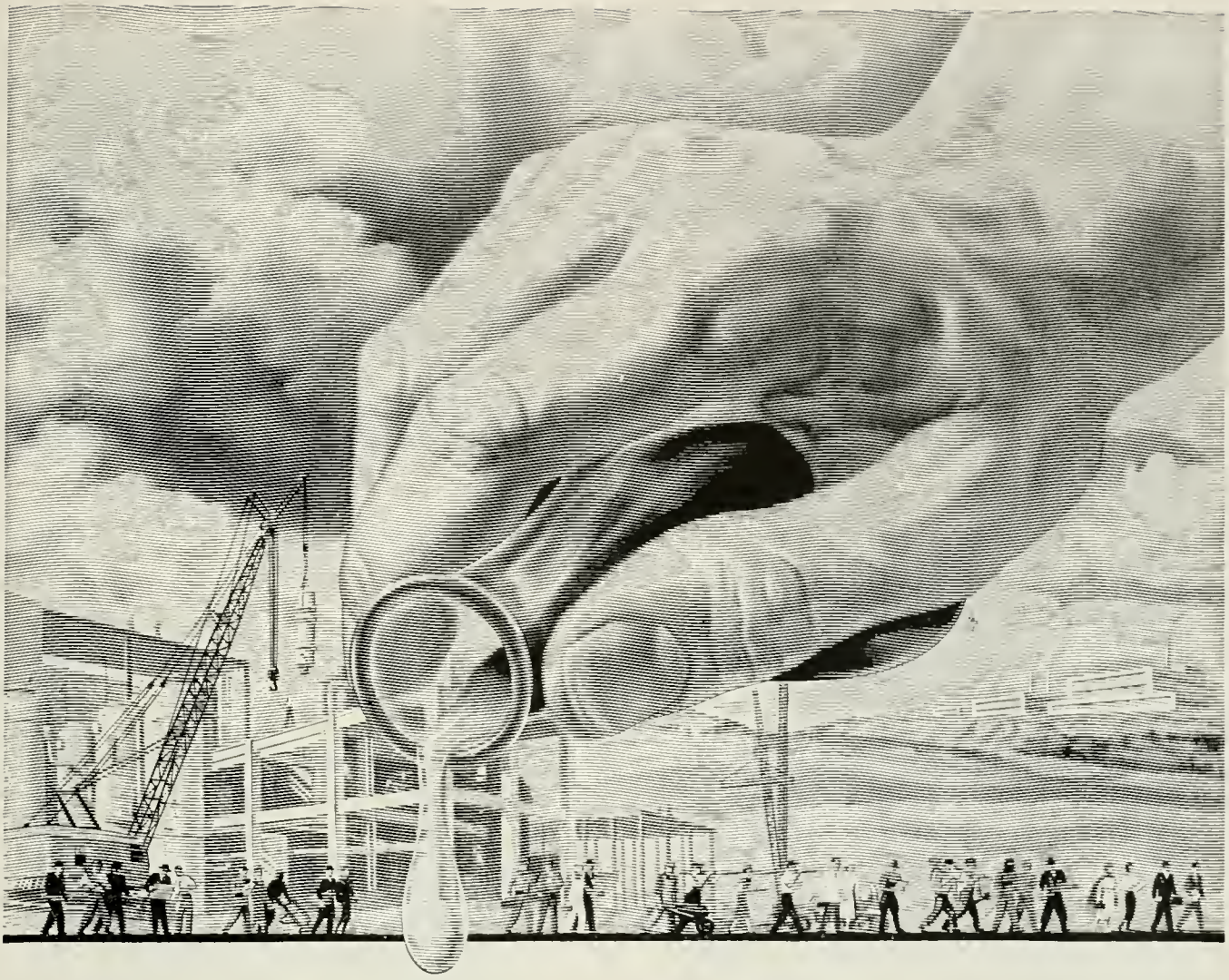
In plain and simple everyday language this merely means that the two rows of four cylinders each are at an angle of 90 degrees with each other. An over-square bore and stroke is so called when the diameter of the cylinder bore is larger than the distance that the piston travels on one stroke. Some of the many advantages of this type of set-up are that the distance that the piston travels at a given R.P.M. is reduced producing longer piston life and less friction.

Hemispherical combustion chambers are just what they are implied to be—hemispheres. The advantage of this is to produce even burning without pre-ignition developing from "hot spots" in the combustion chamber. The best valve arrangement is generally conceded to be the set-up in which the valve actuating mechanism is coupled as directly as possible with the fewest moving parts. What could be more direct or positive than the actuating of each set of valves by its own camshaft!

The four camshafts, each of which runs in five bearings, are driven either by triple roller chains or by a gear train,



The new Pegaso demonstrating its unique top-side entrance. The car has 150 horsepower and weighs approximately one ton.



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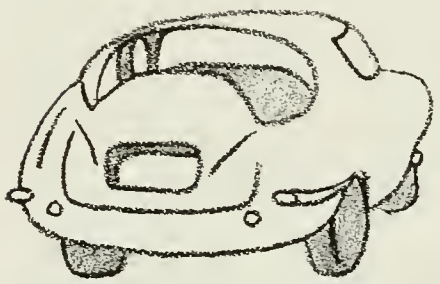
depending on the model engine. Hard liners are set in the cylinder-block, which is cast as an integral unit with the crankcase in a very light but rugged alloy. The pistons are connected with twin connecting rods. A dry-sump lubricating system with an oil radiator is used. This, in other words, means that the lubricating oil is in a sealed system that does not drain into the crankcase but instead flows through the engine and then back to the oil radiator where it is cooled and recirculated.

The advantage of this system is that



the crankcase can be removed for inspection of the bottom of the engine without having to drain and refill the crankcase with oil. Carburetion set ups vary from the using of one to four Weber dual down-draft carburetors.

On the unsupercharged 2.8 liter models, there are three choices of compression ratios. They are 7.8 to 1, 8.2 to 1, and 8.8 to 1 compression ratio, this engine develops 130 horsepower at 6300 revolutions per minute. This is comparable to the Studebaker Champion six-cylinder engine developing as much horsepower as a Ford V-8 truck engine that has 239 cubic inches of displacement.

The standard transmission for this engine has five forward speeds ranging in gear ratios from 13.09 to 1 to 3.78 to 1, plus an overdrive. This certainly would be a transmission-shifters dream come true. This gearbox is mounted in a rear extension of the differential housing.

There is also a variety of optional equipment available for this engine, such as a special Bosch magneto ignition system to replace the standard coil and distributor type.

The story on the supercharged models is entirely different. The compression ratios on the supercharged 2.8 litter engine range from 6.5 to 1 to 7.5 to 1 with a 6.0 to 1 ratio on the 3.2 liter engine, which is only available in the supercharged models.

There are many advantages in supercharging an engine. When dealing with an engine of small displacement, some method is needed to boost the torque output. Supercharing is the answer. The fancy engineering terminology for it is "pressure induction." Since the power output of an internal combustion engine depends basically on the weight of the fuel air mixture it can burn per minute, one of the best ways to raise the output of any engine to its maximum structural capacity is to "blow it," as supercharging is sometimes referred to. Supercharging is nothing more than pumping the fuel air mixture into the cylinders instead of relying on suction.

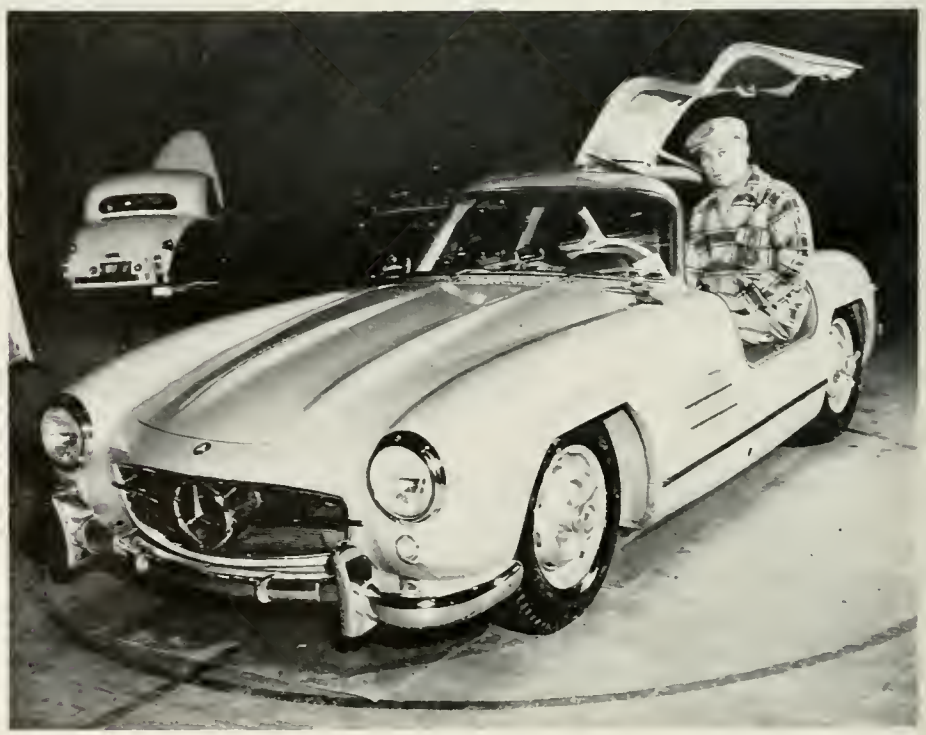
The supercharged 2.8 liter engine, using a compression ratio of 6.5 to 1 develops 190 horsepower @ 6500 revolutions per minute. The 3.2 liter engine, raving a bore of 3.35 inches and a stroke of 2.76 inches, develops 260 horsepower @ 6500 R.P.M.'s. Again comparing it to stock American cars, it is the same as the Rambler engine developing as much power as the new Packard V-8 engine that has 352 inches of displacement.

With a wheelbase of 92 inches and the tallest model standing a mere 51.34 inches, it can well be called a small car. The Pegaso's chassis design is just as unique and perfect as its engine. Front suspension consists of torsion bars in front and behind the unequal-length wishbones, while transverse torsion bars are mounted across the rugged but light tubular frame in the rear. This type of suspension—torsion bars— has just been adopted by one of the American automotive manufacturers, Packard, although their method of mounting them differs from the Pegaso's. With a tread of 52 inches, a 17 inch-diameter steering wheel and a special worm screw steering gear requiring only 1.7 turns from lock to lock, handling characteristics of the car are phenomenal.

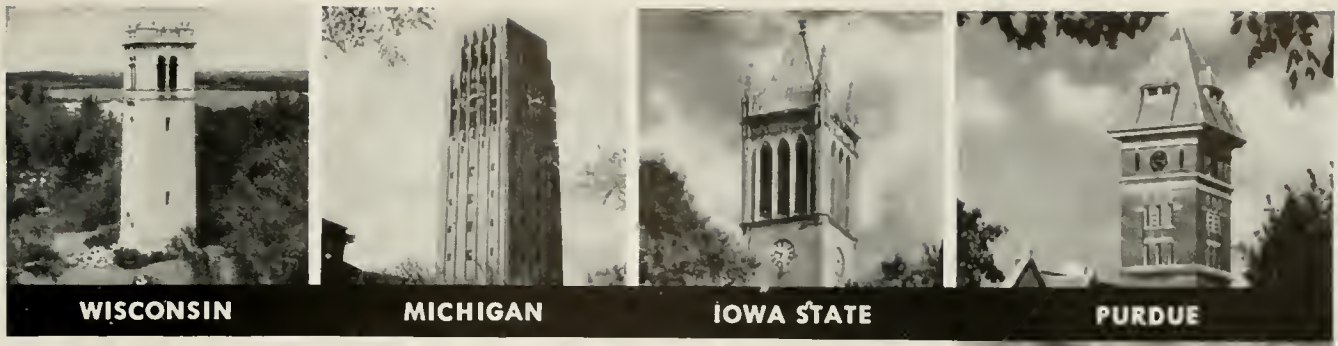
The Pegaso has a turning diameter of only 30.1 feet, which is a little over two American passenger-car lengths. The turning diameter is the diameter of the circle the right front wheel would make when making a left turn with the wheel all the way over. Again this may be compared to the smallest turning radius of American cars by making a contrast to the Rambler's 36 foot turning diameter. Ground clearance of the Pegaso ranges from 5 inches to 6.3 inches, depending on the model. This is a little bit less than the American average ground clearance but is still enough to avoid hitting the driveshaft or parts of the chassis on a rough road.

To stop this wildcat, there are large Lockheed hydraulic brakes on all four wheels. The rear brakes are mounted inboard on the split deDion rear axle. The mounting of the brakes in this manner, plus the rear mounting of the transmission and its own oil pump, plus the deDion rear-end assures a minimum of unsprung weight and the best possible traction under all road and weather condtions. Total braking surface is 190 square inches, which gives an unusually high braking area—between 132 and 136 square inches per ton. This is welcome knowledge when fast and positive stopping is required.

Another unique feature of this braking system is that the brakes function by two independent hydraulic circuits—something that American manufacturers



Dr. Urbas, the owner of this new Mercedes 300 SL sports coupe, recently took fifth place in a 550 Porche in the twelve hour Sebring race. This cor with 183 cu. in overhead cams can do 160 m.p.h. (Photo courtesy Joe Stocks)



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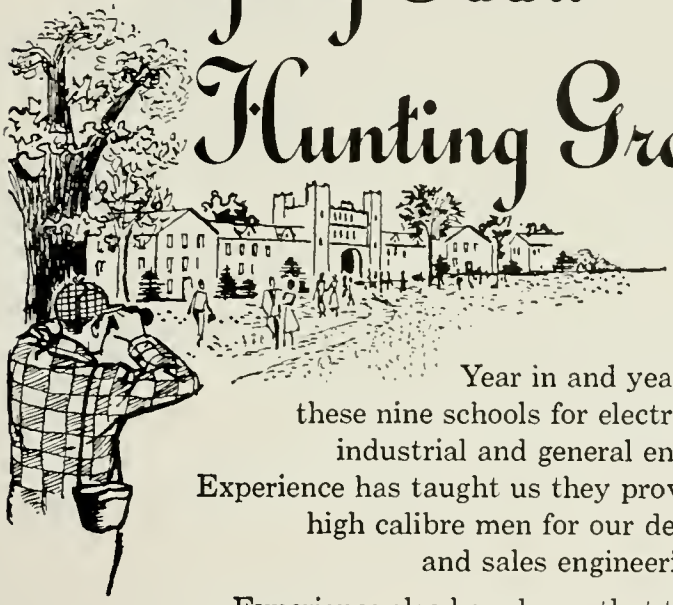

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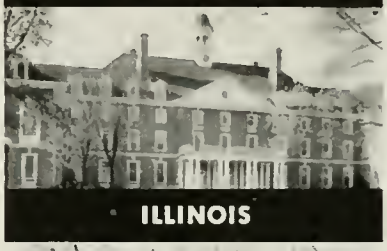

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With a dry weight ranging from 2200 pounds on the unsupercharged 2.8 liter model to 2350 pounds on the 3.2 liter model, the cars are capable of top speeds of 115 M.P.H. to 144 M.P.H., respectively. However, the new 3.2 liter model has been unofficially clocked at 170 M.P.H. The Pegaso also has a pounds per horsepower ratio of 9.04 to 1, in the largest model. This is one of the lowest ratios in the world.

With all of these marvelous feats of engineering combined into one car, it might be thought that the Pegaso would skimp when it comes to comfort. Such is not the case. Comfort has been looked after with as much fastidious care as went into the engineering.

Every luxury item has been included from push-button windows to built-in traveling accessories. Most models also come equipped with thigh-style crash belts and shoulder harness as standard equipment—another hint that Detroit could do well to follow.

Among the company of outstanding racing and sports cars, the Pegaso is sure to hold its own, but one point should be brought up in connection with the car's records of the future. Who is going to take a chance on ruining such an expensive piece of machinery by racing it just for a trophy or a record?

The little tot was sitting demurely on the couch, watching her mother smoking a cigarette. Her nose was wrinkled, and in her pale blue eyes was an expression of child disillusionment. Finally, unable to stand it any longer, she blurted out in her quivering voice, "Mother, when in the hell are you going to learn to inhale?"

* * *

Pants are made for men and not for women. Women are made for men and not for pants. When a man pants for a woman and a woman pants for a man, they are a pair of pants. Such pants do not always last and then they are called breeches of promise. This often turns into a suit. When two couples are mixed up in a suit, all panting, it is a suit with two pair of pants.

* * *

"I'm going to have a little one,"
Said the girl friend, gay and frisky;
But the boy friend up and fainted
Not knowing she meant whiskey!

* * *

Poetry . . .

Both women and pianos
Are similar in brand . . .
Some of them are upright
And some of them are grand . . .

* * *

Lectures are like steer horns—a point her, a point there, and a lot of bull in between.

THE AUTOMOBILE OF TOMORROW

by Siegmar Gresch, M. E. '59

What will the car of tomorrow be like? Will it be a heavy car with a big engine or a light car with a small engine? In order to get a broad view of the possible future of automobiles we must not only look at engine and transmission design, but at the characteristics of the fuels and the total resources. The present trend in the automotive industry is toward higher and higher performance with little attention paid to economy. True, we talk about economy. But are we really seriously interested in economy? There are several factors coming into prominence now which will greatly affect the car of the future.

I. Increased taxes and cost of living tend to encourage more economical cars and lower first cost.

II. Future available supply of petroleum might enforce gasoline economy.

III. Crowded roads and existing parking conditions encourage smaller cars.

In comparing the performance of a big car against that of a small car, we shall compare the average American car with the average European car, keeping in mind that the acceleration is dependent on lb per hp, while top speed is dependent on hp per squ. ft. frontal area. Acceleration varies with the type of transmission. For example, a four speed transmission in the same car. Torque converters wasted power (10 to 12%) until newer models were developed that clutch out in high gear. The steady improvements of automatic transmissions points to more efficient automobiles.

What about top speeds? In comparing top speeds of cars of a few years ago, we find that the top speed of the expensive American car was about 100 M.P.H.; the top speed of the low priced American car was about 85 M.P.H., and that of the foreign car was 75 M.P.H. What good are such high top speeds? In most places the legal speed limit is far below such high speeds, and the only place where one can "open up" is on a trunpike. Even then, the average driver doesn't have the skill to drive a car at 70 M.P.H. Furthermore the horsepower required goes up closely as the square of the speed, so one can see that considerable horsepower increase will not affect the top speed very much. The only instance the foreign car is not quite as fast as the American car is in acceleration. But, the only time that acceleration is useful is when we misjudge passing someone on the highway or when we race the other fellow at the stoplight.

Comparing values of the average foreign car against the typical American car we have the following table:

	H.P.	Weight	Lb. per hp	Hp per sq ft.
American car	125	3,400 lb.	29 lb.	4.3
Foreign car	65	2,300 lb.	411 lb.	2.7

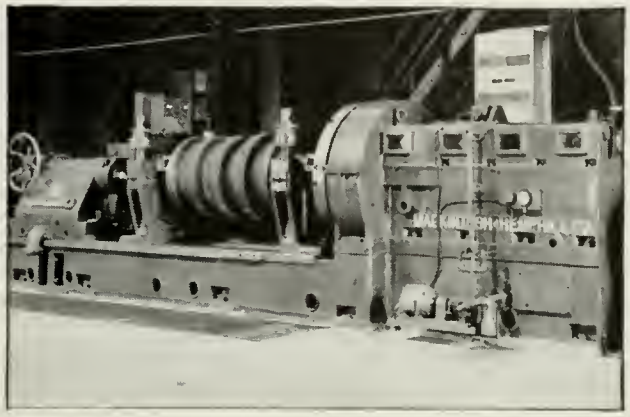
Comparing these figures, we see that the Europeans put 30% less material in their cars and use motors almost half the size of ours. Because the cars are smaller and have less air resistance their top speed is almost equal to ours. Why do we need such big cars? Surveys recently taken show that the average passenger load is 1.3 people. Why should we buy a heavy American car wherein it takes one ton of iron and a few hundred pounds of other material to lug around 200 lbs of flesh when we can do the same job with a ton of iron? In comparing cost, we find that the initial cost of the American car is 25 to 35% more than the popular foreign car. This is not all, let us examine the cost per mile with cars driven 10,000 miles a year.

Comparing figures one can see that the foreign car which is smaller and lighter is much cheaper to operate than the popular American car.

Another component of the automobile which is of considerable interest now days is the suspension system. Typical

Another page for **YOUR BEARING NOTEBOOK**

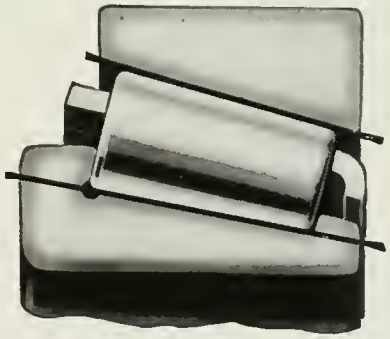
How to carry 35-ton loads in a roll-neck lathe



The engineers who designed this roll-neck lathe were faced with three problems. 1) To build a lathe that would cut finishing time as much as 75%; 2) To build a lathe that would give great accuracy and 3) To provide great load-carrying capacity as well. Their answer was this electronically-controlled mill roll lathe. To carry the 35-ton loads with a maximum runout of .0003 and still do the job quickly, they specified Timken® tapered roller bearings.

Why TIMKEN® bearings have high load capacity

This cross-section of a Timken tapered roller bearing illustrates one reason why Timken bearings do such a good job under heavy load conditions. Notice that there is full line contact between the rollers and races. It's this full line contact that distributes the load over a wider area, gives Timken bearings their extra load-carrying capacity.



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Some of the engineering problems you'll face after graduation will involve bearing applications. For help in learning more about bearings, write for the 270-page General Information Manual on Timken bearings. And for information about the excellent job opportunities at the Timken Company, write for a copy of "This Is Timken". The Timken Roller Bearing Company, Canton 6, O.

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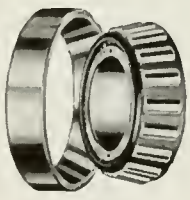
TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION

present day suspension systems employ coil springs for the front wheels and leaf springs for the back wheels. This system has several disadvantages. In order to get a soft, smooth ride, soft springs are used; and as a result, the car sinks a few inches closer to the ground when fully loaded; and hitting a hard bump results in scraping the rear bumper on the road. At high speeds the car tends to sway on the slightest bend of the road.

	Cadillac	Ford or Chev.	Average Foreign
Gasoline	.0205	.0164	.0100
Lubrication	.0025	.0020	.0015
Tires	.0069	.0035	.0028
Repairs	.0086	.0040	.0035
Miscellaneous	.0018	.0018	.0011
Total operating cost	.0403	.0277	.0189
License registration	.0013	.0010	.0008
Insurance	.0109	.0060	.0055
Depreciation	.0407	.0204	.0155
Fixed charges	.0529	.0274	.0218
Total cost per mile	.0932	.0551	.0407

Because the springs are so soft, the bulk of the work of providing a comfortable ride falls on the shock absorbers which slow down the action of the recoil of the springs. As soon as they are worn, the car acts like a rubber ball bouncing half a dozen times everytime it hits a hard bump. A different type of suspension used exclusively by racers and expensive foreign cars in the past has now been adapted to the production automobile. Packard has just unveiled their 1955 models which use a torsion-bar suspension. A single bar on each side of the car takes care of the suspension of the front and back wheels. Levers are connected to each end of the bar at 180 degrees to each other, so that when the right front wheel hits a bump and goes up, the bar is twisted in such a way as to wind up the torsion bar, putting force on the rear wheels. Because the torsion bar is not connected to the frame of the car in any way this action has no effect on the body or chassis, and the result is a perfectly smooth and level ride at all times. Torsion bar suspension is one of the most important recent improvements in passenger car suspension, and unless something better comes along it will be adopted by other automobile manufacturers in time to come.

Certain facts pertaining to gasoline, which have come out into the open may also force the automotive industry to improve their engine designs. In a report given by the Bureau of Mines and American Petroleum Institute, the fact was brought out that the octane rating of gasoline has reached a limit under the present system of catalytic cracking. This is borne out by the fact that the rating of all the major oil companies does not vary more than 2.0. Fuel injection, which would do away with the need for high octane gasoline, may be a possible solution to the increasing demand for high octane gasoline. As in the diesel engine, the fuel would be injected directly into the cylinders, eliminating the need for an intake manifold, making possible a tremendous increase in fuel economy. But because the tolerances have been even closer on a gasoline fuel injection unit than on a diesel fuel injection unit (since gasoline is less dense than diesel fuel) the high manufacturing cost would make the gasoline fuel injection unit impractical. In time new production methods may reduce the cost so that gasoline fuel injection units would be feasible. Whenever the question of fuel injection arises there is always some talk of putting diesel engines in automobiles. The only reason diesel engines are not used in automobiles is that they are too heavy. The great pressures encountered make it necessary to have very thick cylinder walls. In time, metals may be developed which are lighter and have greater strength than those of today and the diesel engine in the automobile may become a reality.

The only type of propulsion which may replace the reciprocating engine in the very near future would be the gas turbine. Using advanced production methods and a generator, a gas turbine could be produced that would compare in cost to the reciprocating engine. Fuel would be no problem since the need for octane rating would disappear. But because of the high temperature encountered in the gas turbine, alloys have yet to be developed so that the gas turbine can compete successfully with the reciprocating engine as a form of propulsion for the automobile. (See December 1954 *Technograph.)*

Safety features of future cars will play an important part in the crusade for safety on the highways. Power brakes together with power steering, will become standard equipment. Air conditioning, with its year-around temperature control, will be part of the standard equipment. In addition, padded dashboards and safety belts will increase the chances for survival in serious accidents.

After examining all the facts, the future points to smaller, smoother riding, more efficient automobiles. After all, it has been known for some time that engines of advanced design having 10:1 compression ratios have been run on 80 octane gasoline. Isn't it logical that some of these engine designs could be used in a modified form on present day engines?

The Volkswagen, commonly called VW, is fourth in sales in the world. The car is perhaps the best engineered passenger car in automotive history.

Superimposed over this man's head is the matrix (or heart) of RCA Electronic "Memory." See description below.

New RCA Magnetic "Memory" recalls thousands of facts in a fraction of a second

Each dot you see in the squares above is actually a magnetic "doughnut" so tiny that it barely slides over a needle point. Despite its size, however, each "doughnut" stores away one bit of information for future reference. And 10,000 of them fit on a framework smaller than the size of this page!

Here are the cells of the RCA magnetic "memory" that is the key element in virtually all high-speed electronic computers. The greatest significance of this "memory" is its ability to deliver, in a few millionths of a second, any information it holds.

Almost instantly, an insurance company can process a claim. Just as fast, a manufacturer with inventories spread around the country can determine what products are making money—and *where*.

With such "memories," electronic computers predict accurately the next day's weather for the nation, using data on atmospheric pressure, temperature, and wind velocity from every part of the United States.

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ELECTRONICS FOR LIVING

DUAL EXHAUST SYSTEMS

by Maurice H. Garnholz

Aero. E. '56

Although among true automotive fans and car bugs, there is almost unanimous agreement on the merits of a dual exhaust system for the present-day automobile, many others who merely drive their cars with only the exterior appearance of the automobile and its parts in mind scoff at such seemingly "juvenile hot-rodders." This article was primarily written for those who are more concerned with the interior workings of their car and, as almost every

MAURICE H. GARNHOLIZ
Maury, lost year's feature editor, has been a contributor off and on to the TECH since his freshman year. As secretary of the Society of Automotive Engineers, secretary-treasurer of the Illinois Rocket Society, and member of the Institute of Aeronautical Sciences, he is kept quite busy.

driver is, with the possibilities of higher performance and better economy.

By the end of 1953, the total registration of passenger cars, trucks, and buses in the United States had climbed to over 55,600,000. As is probably evident to almost everyone with a driver's license, highway building has failed by a dangerously wide margin to keep pace with the increase in vehicle population. Unless one picks the alternative of hopelessly bogged-down traffic jams, vehicles must have the ability to pass slower moving traffic quickly and safely. Greater flexibility in traffic, more power on hills, and more instant acceleration are almost a necessary requisite for ease of driving and consequent safety reasons. Even if the power isn't always used, it should be *available*. Improved performance which car manufacturers have built into their latest offerings has made it almost imperative for those who cannot afford the new models to do something with their current models in order to make them more responsive, if they wish to continue to enjoy driving on highways side by side with the better-performing later-model cars. This, perhaps, is the basic reason for hopping up; *i.e.*, increasing the performance of cars today.[1]

One of the first considerations (in fact, almost *the* first) in increasing engine efficiency and power must be the release of exhaust gases from the engine as quickly and smoothly as possible.

Just as holding one's hand on the front of one's face stifles breathing, so do many of the stock exhaust systems bother the breathing of present-day cars. By improving the intake and or exhaust portions of the breathing cycle, the performance of the car will also be altered toward a higher degree of performance capabilities. Additional performance in the intake part of the cycle is accomplished by more efficient carburetion, intake manifold design, superchargers, air cleaning, etc. But these improvements at the intake portion of the engine's operation can only attain a point anywhere near their highest possible efficiency, if the best obtainable exhausting of the burnt gases is accomplished. For even if a better and faster means of getting the air and fuel mixture to the combustion chamber is accomplished, burnt gases will not be scavenged and removed rapidly enough without a correspondingly rapid and efficient expulsion of these burnt gases. Hence, it is almost mandatory that any improvement made at the intake end of the engine should be accompanied by a similar improvement at the exhaust end. This article is primarily concerned with the expelling of the gases from the running engine.

If one was running down the street and put his hand over his nose and mouth each time he attempted to exhale, he would not run very well, and obviously not at his maximum speed nor efficiency. The same is true of most exhaust manifolds, exhaust pipes, mufflers, and tail pipes. They create restrictions, like the fingers of the hand, resulting in excessive back pressure. Back pressure is a positive restrictive pressure in the exhaust system and is created by several contributing factors. The three most important ones in the form of restrictions can be attributed to (1) mufflers designed for silencing only in which the direction of flow of the exhaust gases is reversed several times, thus eliminating a smooth flow of these gases, *e.g.*, baffles in the muffler; (2) exhaust systems that are unable to handle the volume of exhaust gases created by the engine, thus making it impossible to vent these gases as fast as the engine creates them (This often comes about due to curling pipes and sharp corners in the bends.); and (3) an angular, rough manifold construction which prevents smooth, fast flow of exhaust gases.

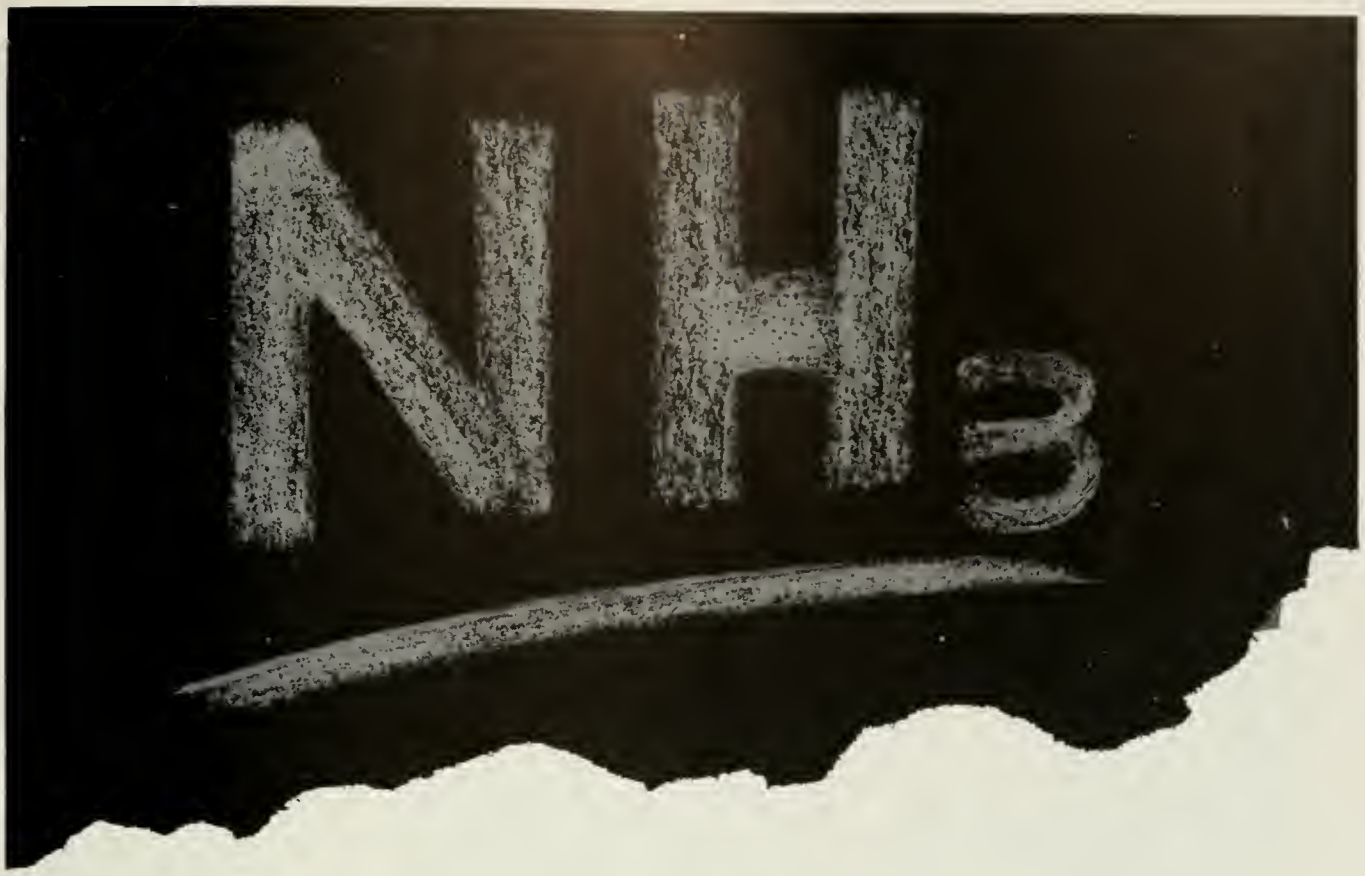
The installation of just one straight-through type muffler, which absorbs the noise by material surrounding a no-bend core, will give an average increase of about 5 per cent both in horsepower and economy (fuel consumption). This varies with car makes and often among the same models. With a dual exhaust system, the increase is *more* than twice this figure. It should be mentioned at this point that the carburetor must be adjusted with the installation of duals, as it was probably set for a single exhaust system previously. Hence, without a new carburetor setting, too rich a mixture of gasoline and air is obtained, which means a waste of gasoline occurs. This is because the dual exhaust system allows the car to run faster without burning as much fuel. Therefore, unused gasoline is just thrown out and wasted. But with a minor carburetor adjustment, the fuel consumption will drop.

These straight-through mufflers are usually packed with either steel shavings or fiber--glass, with the latter often capable of withstanding a temperature of over 1000 degrees Fahrenheit. Even on a stock system (one muffler), such a muffler often reduces back-pressure up to 50 per cent of its former value. They are usually blow-out proof and will often outlast three or four stock mufflers at a fraction of the cost, depending of course on the brand and the conditions they are subjected to.

From *Car Life's* "Economy Driving" is obtained the following discussion on exhausting the dollars. "Back-pressure in the exhaust system is a phenomenon of combustion that is becoming of increasing importance. In older autos it was a simple matter to carry away exhaust gases with relative efficiency through a single pipe. As engines have gained in compression, however, without corresponding additions in size and weight, the exhaust system has tended to resist the efforts of the engine to swallow more air on each cycle and expel it more rapidly (high compression). This resistance is known as back-pressure, and at full throttle may be as much as five pounds per square inch."[2]

By a dual exhaust system with non-restrictive mufflers, one can aid the engine in its labors by achieving a greater volumetric efficiency in the cylinders, which in turn will give a marked increase in acceleration and mileage as well as a cooler-running car.

Restricting our discussion to V-type engines although all improvements in performance apply almost equally well to in-line engines), the merits and whys of a dual exhaust system is further discussed. The conventional arrangement of the flow of exhaust gases in the V-type engines require that the gases leaving the left bank (or right) of cyl-



FORMULA FOR BETTER FARMING

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The development of a better means of measuring instrument bearing torque is but one of many Fafnir contributions to the ball bearing industry. The Fafnir Bearing Company, New Britain, Conn.

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inders must travel through the manifold and cross-over (or cross-under) pipe to join the gases leaving the right bank (or left) of cylinders via the manifold and tailpipe on the right-hand (or left-hand) side of the engine. By the installation of a dual exhaust system, the efficiency of operation is increased due to the fact that each bank of cylinders has its own individual exhaust system, and exhaust gases are carried away independently. With the installation of headers, which will be further discussed later, this technique is carried even further, as each combustion chamber has essentially its own exhaust system independent of the others. It is apparent that by the installation of a dual exhaust system the capacity of the system is doubled, making it possible for the exhaust system to handle a larger volume of exhaust gases in a given time, thereby minimizing back pressure.

When installing an exhaust system to give the best efficiency possible, attention should be paid to the exhaust manifold construction. The internal roughness of cast iron and the sharp angled design of conventional manifolds resist the smooth flow of exhaust gases, and the heat is not dissipated as the exhaust gases leave the cylinders.

By replacing this conventional manifold with a streamlined "header" system, constructed either of cast iron, cast steel, or tubular steel, which permits a smooth flow of exhaust gases to leave the engine, there is a decided improvement in the rate at which the exhaust gases are taken from the engine. This results in faster heat dissipation (cooler running engine), increased efficiency, greater horsepower, and more fuel economy. The V-8 engine lends itself particularly well to the header and dual exhaust system due to the divided cylinder construction (two banks of cylinders). But on the bad side of the case for headers is the fact that they usually add to the vibration noise in the car. This is alleviated somewhat by the use of cast iron headers which absorb much of the noise.

Different sources show different amounts of increase in horsepower due to a dual exhaust system. This variance is due to different makes and different conditions and equipment in the same models. For such a system without headers, tests on the road and on dynamometers show a horsepower increase from 7 per cent to 15 per cent. With dual exhaust header systems the horsepower increase goes up to 30 per cent in some cases. Back pressure is decreased around 70 per cent in both cases. Obtained from several sources, these figures agree with those from the two well-known automotive engineering firms—Almquist Engineering Co., Inc. and Newhouse Automotive Industries.[3-4] Roger Huntington,

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Each time the wheels turned, a bean dropped to a container below the axle. Then Leonardo counted the beans and multiplied by the wheel circumference to learn how far he'd walked.

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of the Society of Automotive Engineers (SAE), states in his book on increasing engine performance that a dual exhaust header system will add at least 10 horsepower to the engine.[5]

One interesting thing to be noted in connection with a dual exhaust header system, with or without straight-through mufflers, is that there is a continuous increase in horsepower with increase in miles per hour of the automobile. With the standard one-muffler car, a maximum in horsepower is reached at a speed of approximately 75 to 80 miles per hour. This is, of course, variable with the cars used. As higher speeds are obtained, the horsepower then decreases with this system. This means there is more labor for the engine when one is driving at high speeds with a standard exhaust system.

The total cost of a header dual exhaust system runs in the neighborhood of $50, with the headers costing approximately $30 and the exhaust system about $20. The latter is composed of two mufflers, exhaust pipe, tail pipe, and fittings.

In conclusion, the case for a dual exhaust system can be summarized as the following. A dual exhaust system provides:

1. Increased gas mileage.
2. Increased maximum speed.
3. Faster acceleration.
4. Faster heat dissipation.
5. Cooler running engine.
6. Better idling.
7. Smoother running engine.
8. Greater horsepower.
9. Less labor on the engine.
10. Increased engine efficiency.

[1]"How to Hop Up Your Chevvy, Ford, or Plymouth," *How To-Magazine*, XIII (Fall, 1954), 4-7.

[2]"Don't Exhaust Your Dollars," *Economy Driving, A Car Life Annual*, No. 101 (1955), 52.

[3]*Almquist Engineering Power Catalog* No. 500 (1954), 4-5.

[4]*Newhouse Automotive Industries Speed Power Economy Catalog* No. 258 (1954), 40-43.

[5]Roger Huntington, *How to "Hop Up" Ford and Mercury V8 Engines*. Los Angeles: Floyd Clymer, 1951, pp. 104-105.

Jet Engine Lubricant

A new silicone lubricant with outstanding thermal and load bearing properties is being vigorously tested.

The silicone fluid has satisfactorily passed thermal stability and viscometric tests ranging from —65 degrees F to 500 degrees F. Steel-to-steel bearing load tests have shown the fluid to have excellent lubricating qualities up to 107,000 pounds per square inch bearing area.

Present commercial silicone oils are well known for their high degree of thermal stability combined with a favorable viscosity-temperature relationship. These oils also possess desirable properties such as high flash temperature and low pour and freezing temperatures. In spite of this array of good qualities, however, they have always been poor lubricants for ferrous metal surfaces under boundary lubricating conditions where the film of lubricant between surfaces approaches the thickness of two or three layers of molecules.

The new lubricating silicone fluid was developed by Dr. Gordon C. Gainer, who supervises chemical department activities of the Westinghouse Materials Engineering Department.

"The problem of developing good lubricating properties for steel versus steel," Dr. Gainer said, "was approached through the modification of the silicone oil molecule." It was assumed that the conventional silicone molecule is not absorbed strongly enough on the steel surfaces to form a close-packed film or protecting layer or layers. As a result metal to metal contact is not prevented on parts that continually rub together. Research studies were thus concentrated on the alteration of the silicone oil molecule to produce a material capable of forcing a surface chemical reaction at the metal oil boundary.

The new lubricant has been tested under the most severe laboratory induced conditions. One such device is the Shell Four-Ball testing machine. Here a steel ball is rotated while held against three steel balls. The entire Four-Ball assembly is immersed in a container filled with the fluid to be tested. While one ball is turned at a constant speed, the other three stationary balls can be accurately pressed against the rotating steel ball, the system acting as a finely controlled "nut cracker." Metal to metal pressures can be built up until the parts actually "seize" or weld in the terminology of lubrication engineers. It is in this piece of testing equipment that bearing pressures of 107,000 pounds per square inch have been attained. Presently available jet engine lubricants will cause "seizure" of the metal parts between 14,000 to 27,000 pounds per square inch bearing area.

"The new lubricant has also been tested in a Westinghouse turbojet engine," Dr. Gainer said. At the completion of this test, the engine was completely torn down and examined. No evidence of wear was found by engineers and the system was entirely free of any sludge derived from the new lubricating silicone oil.

This type of lubricant is being manufactured by Dow Corning Corporation of Midland, Michigan. The latter company is now supplying the lubricant to the military services for further testing.

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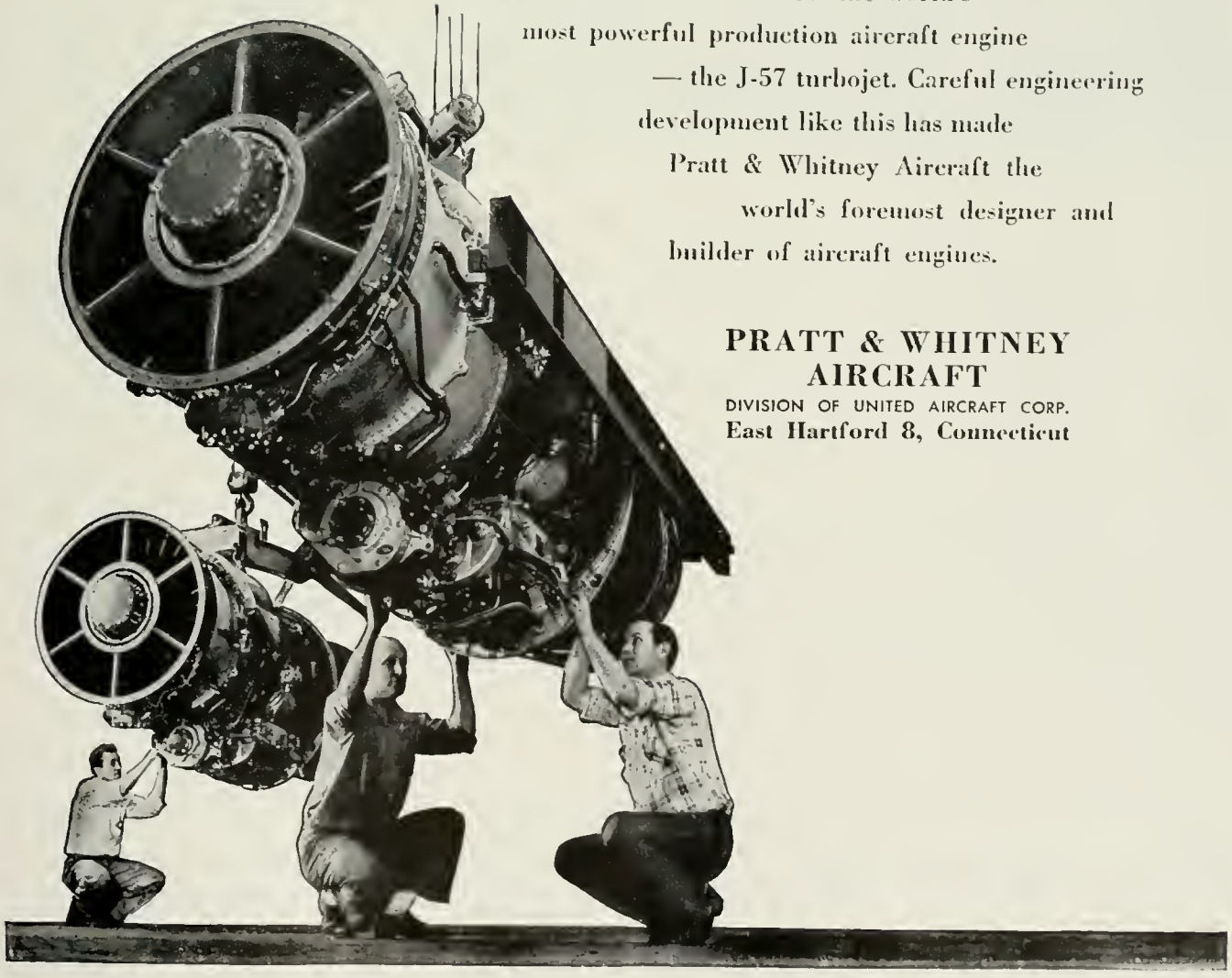
As a result, America now has the world's most powerful production aircraft engine — the J-57 turbojet. Careful engineering development like this has made Pratt & Whitney Aircraft the world's foremost designer and builder of aircraft engines.



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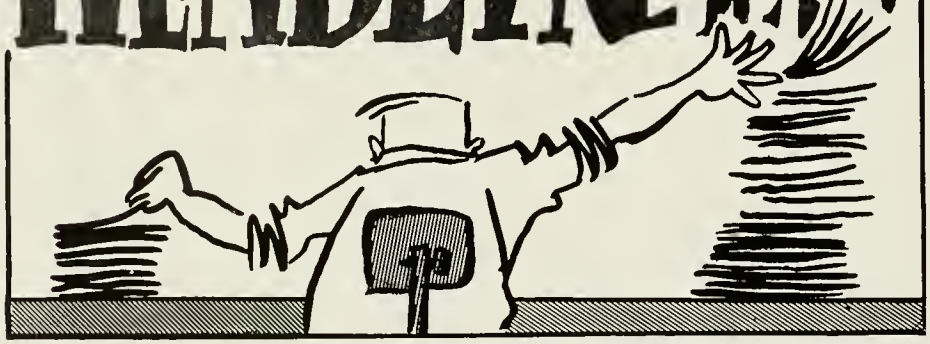


by Larry Kiefling, M. E. '56

Instruments First

Fledgling pilots may learn to fly by looking at instruments before they learn by watching the ground—completely the reverse of usual procedures—if the newest idea being tested at the University of Illinois works out.

While they will not become instrument pilots, they will be able to handle themselves in an emergency when sight of the ground is blotted out. The project is being carried out by the Institute of Aviation and the Aviation Psychology Laboratory at Illinois under a grant from The Link Foundation.

Instrument instruction is being included in training for a private pilot license being given 18 students including one co-ed. Results of the project are expected in July.

The purpose, says Prof. Alex C. Williams Jr., head of the Aviation Psychology Laboratory, is "to demonstrate whether it is possible to give basic instrument and contact training so that in the same amount of flight time a student will be able both to pass the private pilot test and have some knowledge and proficiency in instrument flying."

If successful, this may become a part of the Illinois Flight Plan, developed at the University of Illinois several years ago which—without increasing their training flight time—gives students training and experience in use of an aircraft as well as knowing how to get the plane safely off the ground and back down again.

That plan utilized an open-cockpit Link trainer known as the "School Link." In it are the basic instruments of every aircraft—oil and fuel gages, engine speed indicator, altimeter, turn indicators, and compass—plus the gyro compass and the artificial horizon.

Pilots who know how to use these can keep their craft level without sight of ground, and in time of trouble turn back, come down, go above the overcast, or as a final resort, fly through.

The project has been named "COIN" —Contact-Instrument System of Flight Instruction. Prof. Williams explains that the idea of teaching both instrument and contact flying simultaneously has been discussed for 20 years, but only recently has it been proved that there is a much larger transference of training from instrument flying to contact flying than by the reverse.

Friction Testing Machine

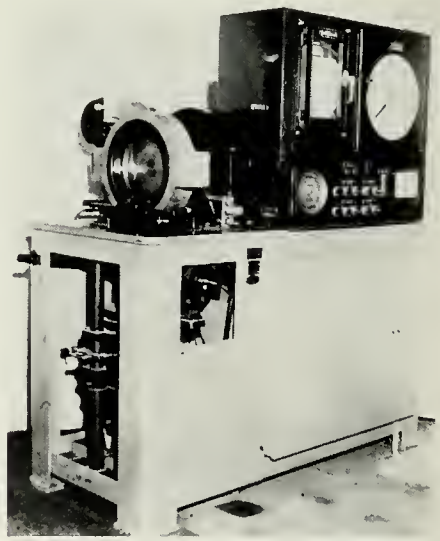
The design and development of a new machine for friction testing of materials under load, such as brake linings, that embodies several new concepts in testing and machine design has been announced.

The design of the machine is based on the fact that if a loaded sample of the material to be tested is held and made to ride on the rim of a revolving drum, at a point on the vertical center line, a horizontal friction force tangent to the drum surface will result.

Because this horizontal frictional force is approximately the same at all speeds, a variable speed-constant torque power unit must be used to power the drum through all speeds and loading conditions desirable to test the material. The revolving drum is mounted on the end of a shaft that is mounted in self-aligning ball bearings. Between these bearings is a flywheel driven by two 'V' belts. Maximum full speed of the shaft is a little more than 900 R.P.M.

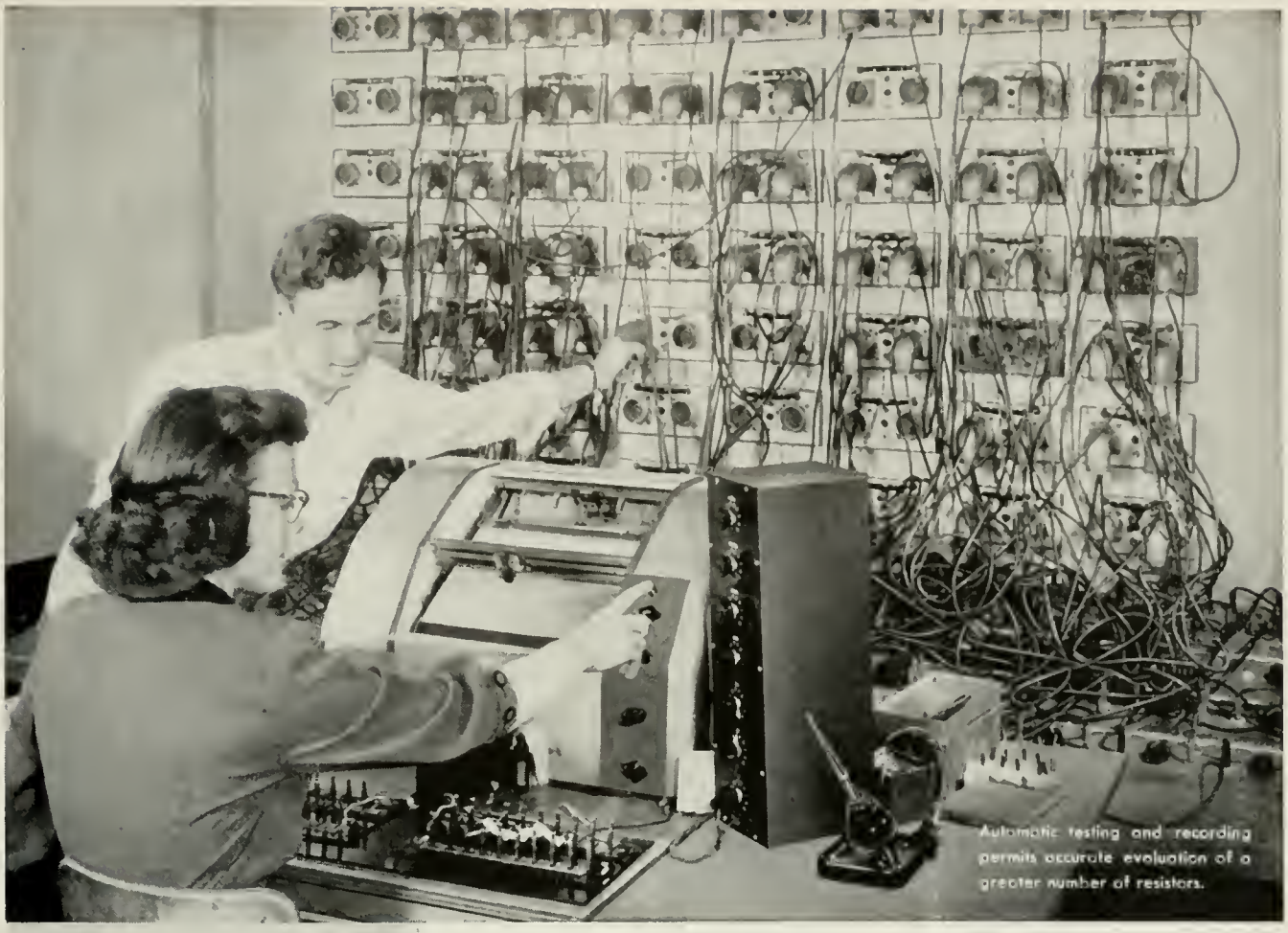
One of the important features of the new machine is a restraining device that has the ability to maintain position of the test sample on the vertical centerline of the drum regardless of any variation of the frictional force. This restraining device, pressure sensitive, measures and makes a continuous record of the characteristics of the material when subjected to any desired condition of operation.

Another important feature of this new method of applying load and transmitting friction force to a measuring device, is that the position of the loading unit is entirely controlled in the friction force line of action by the recording unit itself. The loading unit is kept within the plane of rotation of the force by two small ball end links which are perpendicular to the line of force. This arrangement insures that there are no losses to be considered that would affect the recorded friction force.



Pressures up to 200 lbs. can be exerted against surfaces by this friction testing machine.

In operation a test sample one-inch square is held in a specially designed block which is hinged at the center of the test piece in the revolving drum's plane; this hinged block insures uniform



Automatic testing and recording permits accurate evaluation of a greater number of resistors.

BASIC REQUIREMENTS

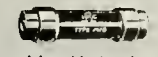
JAN and MIL Specifications are basic guideposts for electronic advancement, whether used as engineering reference points or as procurement standards. IRC's dual emphasis on mass production and exacting testing assures highest performance standards at lowest possible cost.

SPECIFIC EXAMPLES

Type BT Insulated Composition Resistors
MIL-R-11A Specification

IRC Power Wire Wound Resistors
MIL-R-26B Specification

Type BW Low Wattage Wire Wounds
JAN-R-184 Specification



Sealed Precision Voltmeter Multipliers
JAN-R-29 Specification

ONLY IRC MAKES SO MANY JAN AND MIL TYPE RESISTORS

. . . another reason why engineers prefer IRC Resistors

56 different IRC resistors is today's figure—all equivalent to JAN or MIL specifications. Manufacturers of military equipment who must meet these specifications depend on IRC for all their resistor requirements. Offering the widest line of resistors in the industry—138 different types in all—IRC is the logical source of JAN and MIL type units.

IRC

Wherever the Circuit Says

INTERNATIONAL RESISTANCE CO.

401 N. Broad St., Phila. 8, Pa.

In Canada: International Resistance Co., Toronto, Licensee

transverse distribution of pressure and also permits regular examination of the test sample and easy replacement.

Samples under test can be loaded in 25 pound increments up to 200 pounds. For cycling the application and release of the load an air cylinder with a solenoid-operated air valve is provided. Control of the cycling is handled electrically and is adjustable from intervals of ten seconds up to two minutes.

Since the heat resulting from the work done by such a small test piece of friction material is not always sufficient to raise the temperature of the drum to that comparable in brake service, electric heating elements with a capacity sufficient to raise the drum temperature well above most friction materials' critical temperatures have been installed in a housing surrounding the drum. Thermocouples are installed in the drum and lining with current collector rings made of thermocouple materials on the drum hub to provide for indication of the operating temperatures of drum and lining. Records of these temperatures are kept automatically.

Metal Bellows, Device of 1,000 Uses

The metal bellows, an invention that ranks with the rivet and the gear as a useful industrial device, has just begun its second half century in American industry.

For half a century, metal bellows have proved themselves versatile performers in hundreds of different ways. They are found in office buildings, railroad cars, diesel engines, the family auto, in newest jet aircraft and atom plants throughout the country. In heavy industry they control the flow of liquids at just the right temperatures. In contrast, they are found in greenhouses guarding the growth of delicate plants.

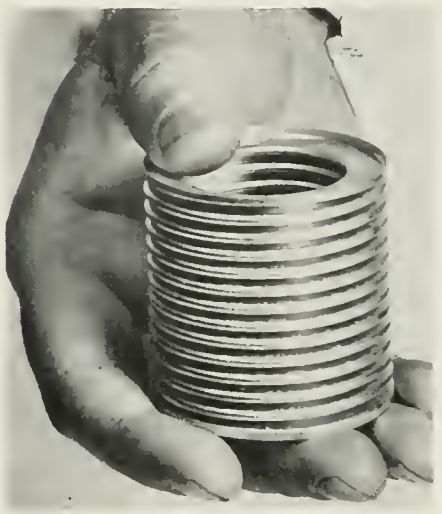
Made from many different metals, bellows are precision-made cylinders whose thin walls have been deeply pleated similar to those of an accordion or folding camera. Once the metal tubes have been corrugated and formed into bellows, they can be expanded and contracted within limits governed by the number of corrugations used. For various uses, bellows are made in diameters ranging from a fraction of an inch to 12" and larger.

Bellows were invented by a Knoxville (Tenn.) weatherman named Weston M. Fulton who was seeking a simple way to measure atmospheric pressure. A local plumber gave him the idea of applying his invention to the development of an automatic damper for steam boilers used in home heating.

The first metal bellows was a soldered brass affair. Undependable at best, the soldered seams would burst under any great stress. Young Fulton experimented with devices for drawing tubes from flat sheets of sterling. Designing intricate dies, Fulton perfected a method of producing seamless metal bellows that were durable and inexpensive to manufacture.

More useful today than ever before, metal bellows are finding new important places in this jet and nuclear fission age. They are being used for oxygen regulators in high altitude aircraft. In these aircraft, bellows assure correct fuel and air mixtures by counteracting changing air pressures. As integral parts of many bombsights, metal bellows help bombardiers lay their explosives "on target."

Bellows assemblies, many fabricated from special steel alloys, are used in regulators and as the packless feature of



Small metal bellows used in oxygen regulating apparatus because of its sensitivity to pressure.

valves at the Oak Ridge atom plants.

First designed as automatic damper regulators for household furnaces, they are now used to make home appliances more automatic, easier to build, and easier to operate; and they've given added safety and efficiency to hundreds of types of machines, buildings and carriers.

At the Knoxville plant, metal bellows are turned out in a smooth and uninterrupted flow from metal stock that is received in strips or coils of specified physical characteristics. In one automatic operation, circles of metal are punched out and formed into deep cups. The cup then goes through a series of drawing and annealing operations, establishing the diameter and wall thickness of the tube. The tube is then trimmed to correct size.

Most bellows under 4⅜ inches outside diameter are formed hydraulically; larger units are formed mechanically with roll dies. To produce the former, the tube is placed in a hydraulic machine and pressure is applied inside the tube, forcing it to take the shape of the corrugated die. The inside diameter of the hydraulically formed bellows is substantially the same as that of the tube and, consequently, "cold-work" is imparted chiefly to the outer bends.

The other process used to make bellows, consists of forming a number of broad corrugations in the tube wall and successively deepening and narrowing these broad corrugations with suitable rolls. The diameter of the tube used making the rolled bellows is less than the outside and greater than the inside diameter of the finished bellows. "Cold-work" is, therefore, imparted to both inner and outer bends, resulting in bellows that have elastic characteristics especially suited for many applications.

The final number of uses for metallic bellows will probably never be determined. So varied are its properties that even veteran bellows experts avoid hazarding a guess. But their usefulness continues to grow as each year hundreds of new commercial applications for bellows are found.

DENTAL SERVICE

An unusual plan in free plant medical examinations is a dental clinic at a Long Island aircraft plant where student dental hygienists from a local college give professional tooth cleaning plus free dental advice. In addition to cleaning teeth, the student technicians examine them for cavities and, where treatment is indicated, refer employees to their family dentists. It's good practice for the trainees, free dental service for the workers and smart employee relations fo rthe company, the magazine points out.

* * *

MAGNETOSTRICTION

The fact that nickel changes in length when it is magnetized has brought about a growing industrial application of the principles of magnetistriction. This property of nickel is applied in high-frequency industrial cutting tools, burglar alarms, sonic depth-finding equipment and submarine detection apparatus and related devices for locating schools of fish.

* * *

PSYCHOLOGY TO THE RESCUE

Psychologists for the National Advisory Committee for Aeronautics had an important role in solving some very tricky problems that had the group's mathematicians stumped. Statistical techniques used by psychologists are able to handle problems that usual mathematics can't touch.

* * *

MECHANICAL MATH

A $135,000 electronic digital computer, recently installed at one oil company's research center, will handle a problem in about 15 minutes which ordinarily would take an experienced refinery engineer about two weeks to solve.

EYE-EXAM for a BATTLESHIP

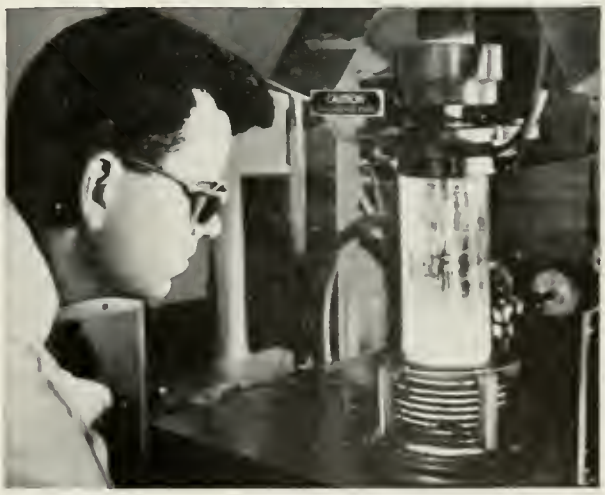
Western Electric field engineers supervise installation of complex electronic equipment made for Armed Forces

Marco Polo had nothing on Western Electric's field engineers. They travel the world to advise on use, installation and maintenance of the electronic equipment we produce for the Armed Forces . . . like radar bombing systems, anti-aircraft fire control systems, and the Nike guided missile control system.

Western Electric is called upon to make these things because of its vast experience with highly complex electronic equipment as the manufacturing unit of the Bell System. It's a job that presents an unending challenge to our engineering staff.

Western Electric

MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM



Western product and development engineers are responsible for turning out some 50,000 different items annually for the Bell System – everything from tiny transistors to giant bays of electronic switching equipment. Shown is one stage of transistor manufacture.

IBM news

FOR ENGINEERING STUDENTS

"IBM's a great place to work," says engineer now in his 8th year with the company

"Every year with IBM is more challenging than the last," says Max E. Femmer, Development Engineer at Poughkeepsie. "It was a tremendous satisfaction in 1952 to help develop IBM's outstanding 701 Electronic Computer. Today, our projects and our work are even more interesting. Both my wife and I think IBM is a wonderful company."
Mr. Femmer is Technical Administrator of the entire Electronic Data Processing Machine Development Program.

IBM Introduces 12 New Products in Year

The 12 new products introduced in the past 12 months dramatize IBM's continuing diversification.

Ranging from the versatile "Cardatype"—a major step forward in the simplification of office work—to the gigantic NORC, the most powerful electronic digital computer ever built, IBM's products serve *all* industries plus government and education.

IBM building 5 new labs

By early next year, 1500 members of IBM's engineering staff will be working in five new buildings now under construction (two sketched above). They will be built at Poughkeepsie, N. Y., and at Glendale, N. Y. overlooking the Endicott Valley.

Ability is quickly recognized —and rewarded

At IBM, lack of years is no handicap. Frequently, the soundest creative thinking comes from young minds. For example, average age of the engineering team that developed the 701, first of IBM's great electronic computers, was 28 *years*.

WHAT A YOUNG ENGINEER SHOULD KNOW ABOUT IBM

IBM is a company on the move! New ideas, new expansion create exciting opportunities.

- IBM has a 41-year record of steady growth. Sales have doubled on an average of every 5 years during the past 25.
- IBM serves all industries, plus government and education—diversified, non-seasonal markets free of the fluctuations of war and peace . . . your best assurance of stability and growth.
- Salaries are excellent—with advancement based on merit. Benefits include company-paid hospitalization, life insurance and retirement plans.

NEW IBM MACHINE AUTOMATICALLY TRANSMITS DATA OVER TELEPHONE CIRCUITS

Instantaneous and accurate transmission of engineering and research data between widely separated computer centers is now a reality, through development of the IBM Transceiver. Using telephone and telegraph networks, the Transceiver duplicates sets of punched cards at remote points—can be used to link plants or branches thousands of miles apart.

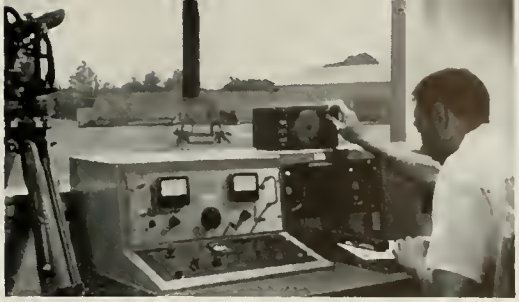
FOR INFORMATION ON IBM CAREER OPPORTUNITIES

Ask at your College Placement Office for a copy of IBM's new booklet "Opportunities Unlimited" or write, giving details of your education and experience to:

W. M. Hoyt, Dept. 334
International Business Machines Corp.
590 Madison Avenue, New York 22, N. Y.

IBM TRADE-MARK

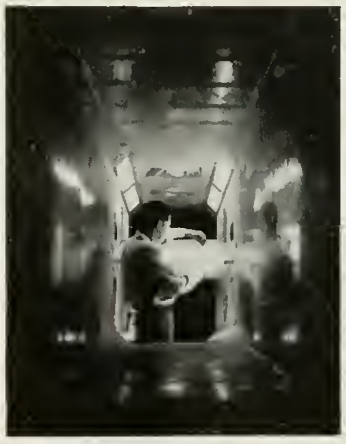
OFFERS YOU A REAL FUTURE



Electronics Research Engineer Irving Aine records radiation antenna patterns on Lockheed's Radar Range. Twenty-two foot plastic tower in background minimizes ground reflections, approximates free space. Pattern integrator, high gain amplifier, square root amplifier and logarithmic amplifier shown in picture are of Lockheed design.

Jim Hong, Aerodynamics Division head, discusses results of high speed wind tunnel research on drag of straight and delta wing plan forms with Richard Heppe, Aerodynamics Department head (standing), and Aerodynamicist Ronald Richmond (seated right). In addition to its own tunnel, Lockheed is one of the principal shareholders in the Southern California Cooperative Wind Tunnel. It is now being modified for operation at supersonic Mach numbers.

Research Engineer Russell Lowe measures dynamic strain applied by Lockheed's 500,000 lb. Force Fatigue Machine on test specimen of integrally-stiffened Super Constellation skin. The Fatigue Machine gives Structures Department engineers a significant advantage in simulating effect of flight loads on a structure. Among other Lockheed structures facilities are the only shimmy tower in private industry and largest drop test tower in the nation.



C. H. Fish, design engineer assigned to Lockheed's Icing Research Tunnel, measures impingement limits of ice on C-130 wing section. The tunnel has a temperature range of −40°F. to +150°F. and maximum speed of more than 270 mph. It is the only icing research tunnel in private industry.

Advanced facilities speed Lockheed engineering progress

Lockheed's unmatched research and production facilities help make possible *diversified* activities in virtually all phases of aviation, military and commercial.

They enable engineers to test advanced ideas which would remain only a conversation topic in firms lacking Lockheed's facilities. They help give designers full rein to their imagination. They make better planes — and better careers.

Engineering students interested in more information on Lockheed's advanced facilities are invited to write E. W. Des Lauriers, Lockheed Student Information Service, Burbank, California.

Lockheed

AIRCRAFT CORPORATION

BURBANK **California**

Technocracks

Scene: A lonely corner on a dark night.

A voice :Would the gentleman be so kind as to assist a poor hungry fellow who is out of work? Besides this revolver, I haven't a thing in the world."

* * *

A CE approached a cigar counter and said, "I usually smoke that brand in the can."

"And that's the best place to smoke them," replied the sweet young thing behind the counter.

* * *

Little Audrey nailed the bathroom door shut and then laughed and laughed, because she knew her big brother and his college friends were having a beer party that night.

* * *

First Dog: "Do you have a family tree?"

Second Dog: "No, we're not particular."

* * *

Dean of Women: "Are you writing that letter to a man, Miss Bagle?"

Miss B.: "It's to a former roommate of mine."

D.O.W.: "Answer my question."

"Did you get home from the party all right last night?"

"Fine, thanks, except that as I was turning into my street some idiot stepped on my fingers."

* * *

As he felt his way around the lamp post, the overloaded engineer muttered, "S'no use, I'm walled in."

* * *

"I knew them danged scientists would keep a-foolin' around until they did something they hadn't oughter," stormed the old man of the hills. "Now look what they've gone and did."

"What's that, Pa," asked his wife, "you mean the atom bomb?"

"Heck no," exploded the old man, "they've discovered something besides likker to cure a cold."

* * *

"Is it a modern farm house?"
"No. Five rooms and a path."

* * *

ENGINEER'S LAMENT

Somehow it seems I cannot think,
Until I've had a little drink.
And when I've had a little drink,
Somehow it seems I canot think.

He: Do you like nuts?
She: Are you proposing?

* * *

First Communist: "Nice weather we're having."

Second Communist: "Yeah, but the rich are having it too!

* * *

Breathes there a man so far abnormal
He can't be stirred by a low-cut formal.

* * *

Mrs. Bunk was going to visit her husband's relatives on H Street.

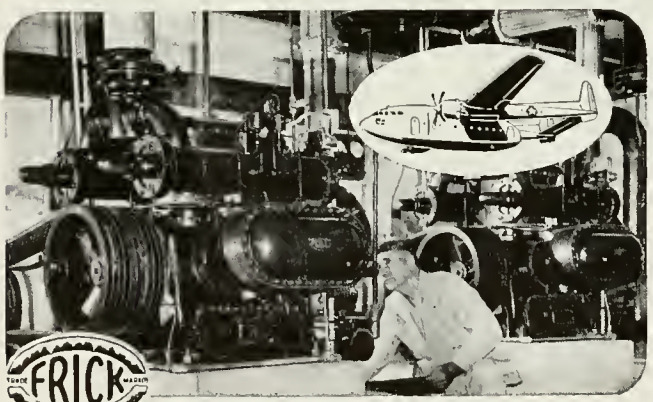
She forgot the number so she wired him from the depot. "Where shall I go to?"

He wired back: "773H."

Mrs. Bunk read it upside down and now she's suing for a divorce.

CHANGE OF COVER

Due to technical difficulties, the originally scheduled cover described on the contents page could not appear. Instead is shown Lincoln hall, one of the busiest class buildings on campus. It houses, among other offices, those of the College of Liberal Arts and Sciences and several of its departments. Two museums and a theatre also are located in this building.



AIR CONDITIONING

Frick Company recently completed the engineering and installation of a year 'round comfort air conditioning system for the new office annex of the Fairchild Aircraft plant in Hagerstown, Md., where they manufacture their famous C-119 Flying Boxcars.

The cooling load of 245 tons of refrigeration is carried by two Frick "ECLIPSE" 9-cylinder high-speed compressors.

For the latest in air conditioning and refrigeration engineering and equipment, look to Frick Company, now in its second century of service to business and industry.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, offers a career in a growing industry.

DEPENDABLE REFRIGERATION SINCE 1882
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Necklace of Linde Star Rubies and Diamonds worn at the Coronation of H. M. Queen Elizabeth II.

Man-made gems perfect as nature's finest—

created with the aid of photography's keen eye

Linde Air Products Company measures rare elements as close as 2 parts in a million with the spectrograph to produce star sapphires and star rubies more nearly perfect than natural gems.

Wartime instruments called for millions of synthetic jewel bearings. But supplies from Europe were shut off. So at Uncle Sam's request, Linde, a division of Union Carbide and Carbon Corporation, undertook to create sapphires and rubies—with photography filling a role in the intricate technology.

Postwar, Linde went even further. Using the spectrograph, a photographic instrument so sensitive it can measure the chemical content of celestial bodies, they found just the right trace of rare element to create a deep silky star within the stone and thus achieved the fabulous Linde "Stars"—man-made counterparts of one of nature's rarest gems.

This is the way photography is working in small companies and large, in laboratories, on production lines, in offices and drafting rooms. It is saving time, reducing error, cutting costs, improving production for all kinds of business and industry.

Graduates in the physical sciences and in engineering find photography an increasingly valuable tool in their new occupations. Its expanding use has created many challenging opportunities at Kodak, especially in the development of chemical processes and the design of precision mechanical-electronic equipment. If you are a recent graduate or a qualified returning serviceman, and are interested in these opportunities, write to Business & Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.

Eastman Kodak Company, Rochester 4, N. Y.

WHERE PROGRESS IS UP TO YOU...

How will you help to sharpen radar's "eyes"?

Exact range and accuracy of the radar antennas shown here are classified. But this can be told—the radio energy transmitted can light fluorescent lamps 100 feet away.

Progress in radar, as in the entire field of electronics, has been rapid. At General Electric much credit for these advances belongs to engineers who are recent college graduates. Take, for example, E. B. Carrillo, EE, Pratt Institute, '49, responsible for manufacture of servo- and time-sharing systems, and G. G. Wilson, EE, N. Y. U., '48, in charge of design and development of remote control equipment.

The work of these young men typifies GE's emphasis on young, creative engineers from such fields as electrical, mechanical, metallurgical and aeronautical engineering, and from the scientific fields of physics and chemistry. Like other graduates, Carrillo and Wilson were able to increase their engineering awareness in the after-graduation G-E program of technical assignments. In this program, the engineer selects the fields, the locations himself. And at G.E. you will be able to make real contributions early in your career in activities ranging from plastics to large electrical apparatus, electronics to jet propulsion, automation components to atomic power.

For full information on the job at G.E. suited to you, consult your college placement director, or write General Electric Company, Engineering Personnel Section, 1 River Road, Schenectady 5, New York. TR-2A

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May, 1955

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Illinois Technograph

James Chisholm, class of '41,
speaks from experience when he says,

"Men with ability and ambition really have a chance to get ahead at U.S. Steel"

• A responsible position can come quickly to those graduate engineers at U.S. Steel who show ability and ambition. Management training programs are designed to stimulate and develop these qualities as the trainee "learns by doing." His training is always a fascinating challenge and he works with the best equipment and the finest people in the business.

James Chisholm is typical of the young men who rapidly rise to an important position at U.S. Steel. Jim came to U.S. Steel as a trainee in 1941 after graduating as an M.E. Shortly thereafter he entered military service for four years. Upon his return to U.S. Steel in 1946, he advanced steadily until, in 1951, he was appointed to his present position as Assistant Superintendent of Blast Furnaces at the new Fairless Works at Morrisville, Pa.

Jim is now in charge of the unloading of all ore ships and the operation of the plant's two big blast furnaces—each with a rated output of 1500 tons per day.

Jim feels that the opportunities for graduate engineers are exceptional at U.S. Steel. He remarked that in his own department alone, six college trainees have been put into management positions within the last couple of years. He says that chances for advancement are even better now with the current expansion of facilities and the development of new products and markets.

If *you* are interested in a challenging and rewarding career with United States Steel, and feel that you can qualify, you can get details from your college placement director. And we will gladly send you a copy of our informative booklet, "Paths of Opportunity," which describes U.S. Steel and the openings in various scientific fields. Just write to United States Steel Corporation, Personnel Division, Room 1622, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

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OIL WELL SUPPLY . . TENNESSEE COAL & IRON . . UNITED STATES STEEL PRODUCTS . . UNITED STATES STEEL SUPPLY . . *Divisions of* UNITED STATES STEEL CORPORATION, PITTSBURGH
UNITED STATES STEEL HOMES, INC. · UNION SUPPLY COMPANY · UNITED STATES STEEL EXPORT COMPANY · UNIVERSAL ATLAS CEMENT COMPANY 5-690

CATERPILLAR MACHINES POWER THE WORLD'S GREAT ENGINEERING JOBS

The young engineer who works for Caterpillar Tractor Co. has a part in great achievements. All over the world new construction is going forward at an unprecedented pace. And the powerful diesel engines and earthmoving machines built by Caterpillar are leading the way.

This is a dynamic industry—an industry of growth. In the next few years engineering strides made by Caterpillar will surpass all that have gone before. To share in this advance the company needs young men of vision, trained as Mechanical, Metallurgical, Agricultural, Electrical, Civil Engineers and others. They will do challenging work in research and development, design, manufacturing, sales and many other fields. They will have the best in laboratory facilities and interesting assignments in Caterpillar plants as well as in the field.

Such men can expect permanency and promotion. Starting pay is good. In addition, executive positions at Caterpillar are filled from within the organization.

It's time now to start thinking about a Caterpillar job. Representatives of the company will be on campus for interviews. Consult your placement office. Meanwhile, if you would like further information, write to W. C. van Dyck, Employee Relations General Office, Caterpillar Tractor Co., Box IL-4, Peoria, Illinois.

CATERPILLAR

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DIESEL ENGINES • TRACTORS • MOTOR GRADERS • EARTHMOVING EQUIPMENT

NEW PRODUCT in the air conditioning field is Worthington's ultra-modern winter and summer home air conditioner. It's a compact package that heats, cools, circulates, filters, and controls humidity. Like every Worthington product, this good-looking unit is designed and built for a lifetime of quiet, efficient service.

Making today's BIG news in air conditioning

NEW BUILDING in New York is the glass-sheathed Manufacturer's Trust Building. It's cooled by a Worthington central station system—so big it does the same job as melting 300 tons of ice daily.

NEW LIFE FOR OLD STORES. Shoppers stay longer, buy more in stores cooled by Worthington units with the new "Million Dollar" compressor. New 3-D circulation aims comfort right where you want it.

Worthington's new residential air conditioners, packaged units, big central station systems — all are making headlines in the air conditioning field. And the same research and engineering skills responsible for their development are applied to all Worthington products — engines, turbines, compressors, construction machinery, as well as pumps.

For the complete story of how you can fit into the Worthington picture, write F. F. Thompson, Mgr., Personnel & Training, Worthington Corporation, Harrison, New Jersey. 4.25D

See the Worthington representative when he visits your campus

See the Worthington Corporation exhibit in New York City. A lively, informative display of product developments for industry, business and the home. Park Avenue and 40th Street.

WORTHINGTON

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LIQUID METERS • MECHANICAL POWER TRANSMISSION • PUMPS • STEAM CONDENSERS • STEAM-JET EJECTORS • STEAM TURBINES • WELDING POSITIONERS

More and better jobs for more people

GENERAL MOTORS President Harlow H. Curtice speaking:

"Just as an example of how job opportunities in General Motors have grown, here is what has happened since 1940.

"In 1940, we had 233 thousand employes on our payrolls in the United States and Canada. In 1955, our employment totals 520 thousand —an increase of 287 thousand good jobs in only 15 years."

It stands to reason that a climate where job opportunities expand with such rapidity must be especially fruitful of career opportunities for young men holding engineering degrees.

For, in the final analysis, the very life's blood of our organization is the never-ending production of "more and better things for more people"—and that, very definitely, requires the engineering mind at its best.

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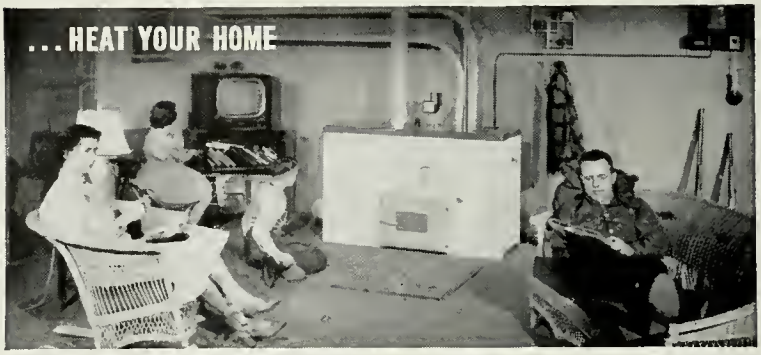

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THE ILLINOIS TECHNOGRAPH

volume 70 number 8

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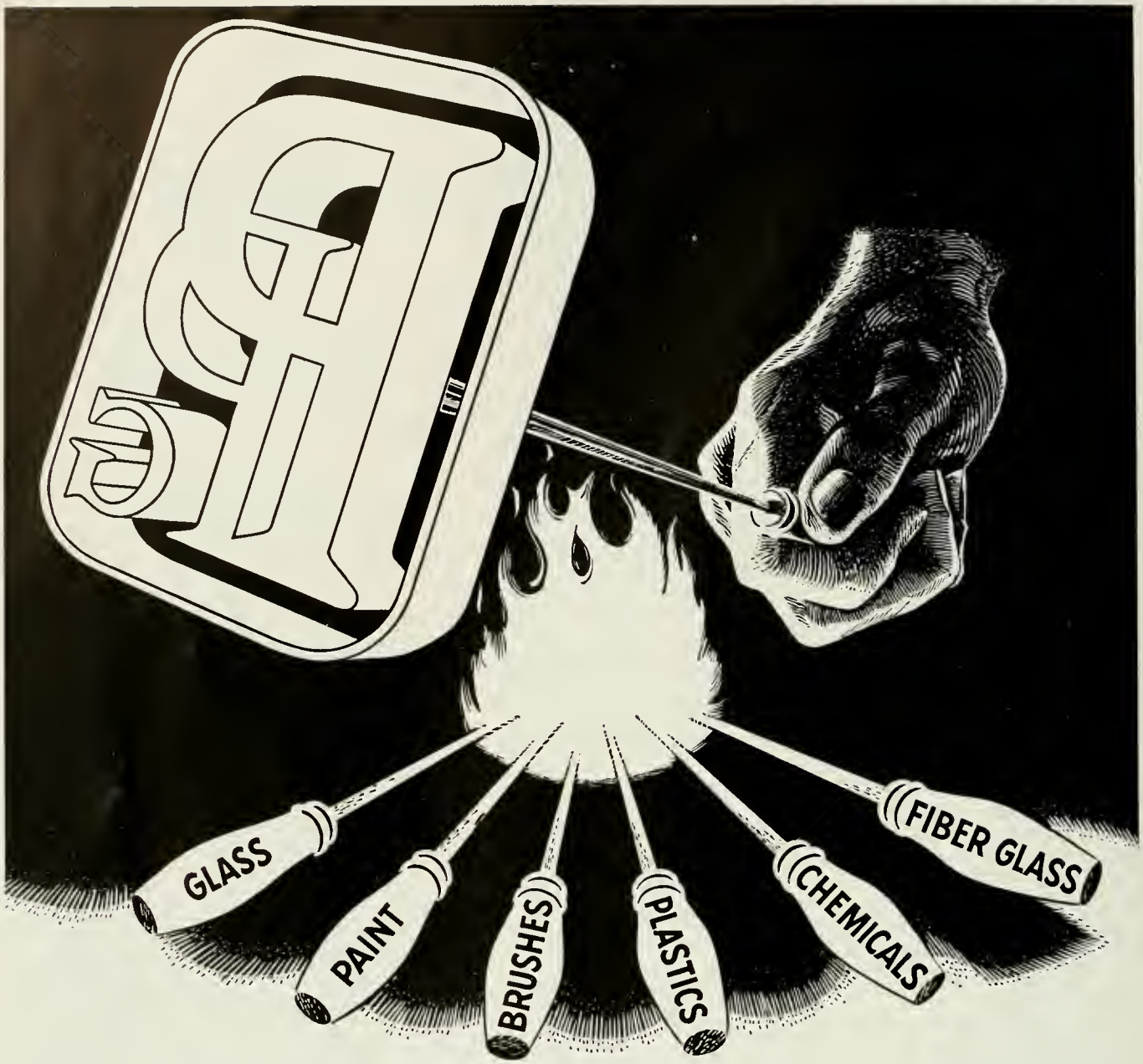
our cover

Civil Engineering Holl is the original engineering building on the Illinois campus. Today it not only houses the Civil Engineering Deportment, but olso the offices of the College of Engineering.

our frontispiece

Radar is one of the most useful things on o bottleship. The cannon can do very little without radar, and the radar needs the trusty gun to do its domage.



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1927—Unloading cargo from Boeing mail plane

1955—Loading Boeing C-97 Stratofreighter

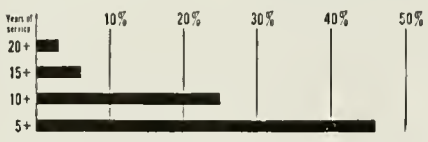
There's plenty of variety in Boeing engineering careers

America's pioneer passenger-cargo aircraft, the 40A, was a Boeing. So is the Air Force's versatile tanker-transport, the C-97 Stratofreighter shown above.

During the company's 38-year history, Boeing engineers have blazed new trails in the design of aerial freighters and tankers, commercial airliners, flying boats, fighters, trainers and bombers. Today Boeing continues to offer engineers a wide variety of opportunities in Research, Design and Production.

Students sometimes are surprised that Boeing's engineering staff includes those with civil, electrical, mechanical, aeronautical and other engineering degrees. Yet all find application in aviation. For example, the civil engineer may work on airframe structure or stress. Electrical engineers find challenge in the complicated electrical and electronic systems of modern jet bombers and guided missiles. Other engineers will find similar application for their talents.

The high degree of stability in careers at Boeing is reflected in this chart.



It shows that 46% of Boeing engineers have been with the company five or more years; 25% for 10 or more years, and 6% for 15 years.

Boeing promotes from within, holds regular merit reviews to assure individual recognition. Engineers are encouraged to take graduate studies while working and are reimbursed for all tuition expense.

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THERE'S A SILICONE IN YOUR FUTURE

by Donnie Snedeker, E. E. 58

"If a silicone were a woman, you'd forget all about your first love and your pet cover girl. You'd set off in quest of the silicones, because they have all of the virtues you dream about but never find in one woman."[1]

Back in 1942, the coast of Europe was well known and the coast of China had been explored. Columbus assumed, therefore, that if he sailed west from Europe he would land on the coast of China. No one then knew that a great continent lay between Europe and Asia.

A similar condition had existed in the chemical world until the turn of this century. For years men had known about inorganic materials such as ceramics, glass, and metals. The field of organic chemistry had also been explored and chemists had developed plastics, rayon, and thousands of synthetic organic materials in the more recent past. No one knew that "between these two fields lay a new chemical continent of semi-inorganic materials known today as silicones."[2]

Silicones are synthetic compounds composed of silicon and orygen from the inorganic field and hydrocarbons from the organic fields. These substances are never found combined in nature and they don't join readily by chemical means. For this reason their combination is often thought of as a chemical "shot-gun wedding."[3]

Once this marriage has been completed and the silicones are formed, it takes considerable energy to break them down. This results in remarkable properties which accounts for the wide variety of uses for silicone compounds.

Before a substance can have this potentially infinite number of uses it must first be discovered and developed. Early experimentation was probably hindered by the lack of natural products to study. From the very beginning synthetic methods had to be developed. This task was undertaken by some of the ablest scientists of the nineteenth century—Crafts, Landenburg, and Friedel. Their studies enlarged the knowledge of silicon, the element, and laid the ground work for preparation of silicones. The methods they used were rather laborious and the results were not particularly remarkable. Consequently, silicones were were pretty much forgotten until the turn of this century when an English professor began his 43 years of monumental research into the field.[4]

In 1901 Professor Frederic S. Kipping of the University of Nottingham in England published the first of 54 papers on the subject of silicone research.[5] The professor, who died in 1949 at the age of eighty-five, has been described as a "distinguished, meticulous, revered scholar and teacher, and a good man with billiard cue, tennis racket, and cricket bat"[5] who "devoted more than four decades to the basic investigatio ns which now support modern silicone science."[6]

Kipping was not interested in the uses for silicones, but he primarily directed his work toward preparation and characterization of new compounds, and a study of their reactions. He and his students isolated these compounds in an effort to obtain pure compounds. Their equipment often became clogged with "uninviting" glues and oils. Some of their products were gases, many were liquids and solids, and several were labeled as "glass-like messes." These products were found to be composed of long chemical chains of alternate silicone and oxygen atoms with various hydrocarbon groups attached to the silicon atoms like branches on a tree.[7]

The Grignard reaction,[8] a most effective means of attaching organic groups to silicon, was discovered by Kipping in 1904, which made it simpler for others who were beginning to work in this field. Alfred Stock of Breslau began studying compounds in which hydrogen atoms were attached to silicon. He found that the longer chains are less and less stable. This study opened the door for Bygden's work on the analogous physical properties of certain carbon compounds and similar silicon compounds.[10] Many scientists dabbled in silicon research but up until industry's plunge into the field the major advances were made by Professor Kipping and his students.

Russia tried to get in on the show in 1930 when their scientists released a number of papers on the subject. They were the first to sense the industrial value of various types of silicon compounds, but they failed to follow up. Dr. Kreshov of the Mendelsef Institute in Moscow stated that the reason Russia did not pursue such an encourgaging start could be attributed in part to the lack of magnesium to operate the Grignard method. Recently they have published reviews of previous work and reports of developments in America which might indicate a renewed interest in the subject.[11]

About the time Kipping and his associates were cleaning the "glass-like messes" from their test tubes, American scientists were turning these basic discoveries into a new chemical industry. Glass manufacturers were looking for a resin which would match the properties of glass fibers. Officials at Corning Glass Works of Corning, New York, saw the possibility of such a resin in Kipping's silicones. They engaged Dr. J. F. Hyde, an organic chemist to head their research.[12] In 1935 Corning introduced Fiberglas cloth, woven of glass fibers. Fiberglas looked promising as an electrical insulation material if some non-conducting, heat-stable impregnant could be found for a good bond. Studies and experimental work began along these lines by Dr. Hyde. He made hundreds of silicone resins that were either too stiff or too sticky before he finally came across one that seemed to have the ideal

combination of the needed properties. Then Corning began contacting electrical companies about their new discovery and they extended their research activities to a fellowship at the Mellon Institute in Pittsburgh under the direction of Dr. Rob Roy McGregor.[13]

With their experimental research going full speed, Corning officials decided to join forces with a large chemical manufacturer in order to go into full scale production. They contacted Dow Chemical Company because Dow was the largest supplier of magnesium, which was a major ingredient in the Grignard method of producing silicones. The officials at Dow agreed and in 1943 the Dow Corning Corporation was formed with headquarters at Midland, Michigan.[14] The new corporation's first product was a "smooth, colorless compound that looked and felt like white petroleum jelly, remained jelly-like at any temperature from 40° below Zero to 400° above, and blocked both water and electrical currents."[15] This jelly, called DC (for Dow Corning) 4, was used as an ignition-sealing jelly for sparkplug terminals on fighter planes. This product played an important part in preventing ignition failure during World War II.

While this first product was making history, Dow Corning officials were selling the Navy Department on insulating submarine motors with silicone-resin impregnated Fiberglas. After a tour of the Dow Corning pilot plant, Admiral Rickover—then head of the electrical section in the Bureau of Ships—was thoroughly impressed and convinced, and he contracted them to begin construction of silicone-insulated motors. This contract made it possible for Dow Corning to construct a $3,000,000 plant which they had operating by 1944. They were testing experimental silicone-insulated motors when the war ended and the silicone market collapsed temporarily.[16]

Although Corning was the first company to consider silicones seriously, General Electric was not far behind. In the middle 30's they began research under the guidance of Dr. Eugene Rochow and Dr. Winton Petnode. Dr. Rochow developed the "direct method" of producing silicones which has become the key to modern volume production. It replaces the slow and complex Grignard method that was used by Professor Kipping and his students.[17]

By 1938 General Electric had succeeded in developing a silicone insulation that was remarkably resistant to heat, water, and most chemicals. One of the G.E. scientists, Dr. J. G. Wright, in the midst of his experiments, discovered the black sheep of the silicone family—bouncing putty. This turned out to be of little practical value, and it may be remembered as a Christmas novelty of a few years back. It stretched like elastic, drooled like tar, bounced like a ball, or cracked like peanut brittle.[18]

With laboratory competition in full swing many discoveries were made accidentally. One day Dr. Maynard Agens of G.E. noticed that a silicone liquid had reacted with a metal stopper to form a rubber substance. He developed a simple production process and, because of the silicone rubber's astounding heat stability, G.E. began using it to replace the rubber gaskets in their turbochargers during World War II. By the end of the war General Electric had advanced far into the field of silicone research.[19]

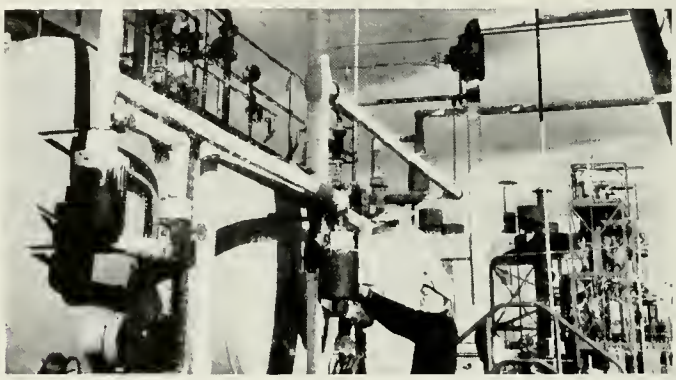
Dr. W. R. Collins, vice president of Dow Corning, once said, "Our salesmen have one big problem. When they are looking for new business, they don't know where to stop. Any plant they go by—no matter what they make—could find a use for silicones."[20] Apparently other companies saw this great diversification in the store for silicones, also. In 1949 the Plaskon Division of the Libbey-Owens-Ford Glass Company began selling silicone products. Their attention is being mainly directed toward paints which combine silicones and alkyd coatings to obtain covering characteristics between porcelain and paint. Plaskon ranks as fourth in present day silicone production.[21]

Ranking third in production of silicones is a newcomer—Linde Air Products Company, a subsidiary of Union Carbide and Carbon Corporation. They recently completed construction of a $13,000,000 plant at Long Reach, West Virginia. Unlike the other silicone producers Linde has its own supply of silicon. It comes from a fellow subsidiary, Electro Metallurgical Company.[22]

As has been previously mentioned, silicones are a combination of sand, oxygen, and hydrocarbons. They combine the best properties of these groups to produce astounding results. The silicon and oxygen partners give the silicones their stability, i.e., their ability to resist heat, cold, chemicals, and weather. The hydrocarbon partner makes silicones flexible. By varying proportions and types of this partner, the chemist can produce silicones ranging from volatile liquids to stable solids. "Millions of silicone combinations are theoretically possible," according to Dr. Charles E. Reed, general manager of G.E.'s Silicone Products Department.[23]

More important than the appearance are the four basic properties of silicones, none of which has yet attained maximum use. First, silicones offer outstanding resistance to extremes of heat or cold. They remain stable, retaining their properties, up to about 550° Farenheit or as low as 120° below Zero.[24] The heat stability of silicones is an inherent feature in their chemical structure. It makes them a very suitable electrical insulation material in complement with fibrous glass, mica, and asbestos insulating materials. Silicones can serve as a bonding agent to hold these materials together and also to bond them to the metal. An application of this property of silicones is its use in heater ducts for jet aircrafts, which are subjected to opposite extremes between the hot-air blasting through them and the freezing temperatures outside.[25]

A second inherent feature in silicones is their amazing release characteristics. Certain silicone compounds apparently fail to react with most other substances. This makes it possible for them to be used in such strange places as the deicer boots on aircraft wings. Many manufacturers of molded articles are taking advantage of this property of silicones by using them as release agents. A thin film is spread over the metal die and the hot rubber or plastic article will not stick.[26]



One of General Electric's plants which has all of the outside pipes and tanks covered with multicolored silicon coatings to protect them against the weather. A standing testimonial to its products.

This pretty model appears mystified by the strange bouncing putty. A Christmas novelty of a few years ago, bouncing putty bounces like a ball, drools like tar, or shatters like glass when struck hard.

The U. S. Army has plans to make use of silicon's ability to repel water. This silicon cooted compass will always function properly without any danger of water entering the case.

Water-repellency is another surface property of major importance for silicones. When a surface is coated with silicones, the silicon-oxygen partners attach to the surface, leaving the hydrocarbon partner exposed. This acts like a paraffinic umbrella for the rest of the molecule. Multiplied by each of the molecules this forms a waterproof raincoat for the surface. Although silicones keep the water out, they allow air to come in because the silicones coat the pores without clogging them.[27]

In many instances the chemical inertness of silicones can be a manufacturer's asset. Often this versatile substance can be extremely lazy, and therefore useful. Silicones refuse to react with most materials, which enables them to resist decomposition and weathering. An example is silicone fluid coatings on porcelain that shed dirt, won't crack under hot sunlight and resist formation of continuous films of water. Silicone rubber is insoluble in most organic solvents. This allows silicone rubber to be used as a selant on small transformers that will not contaminate the liquid electrolyte.[28]

These vital characteristics of versatile silicones are being put to work in many commercial products for both consumer and industry. The first such product was an eyeglass cleaning tissue called "Sight-Savers." Made by Dow Corning, these pink-colored tissues drew nationwide attention to silicone products. Today they may be found in 80 per cent of the nation's drug stores. Many

Here a scientist tests silicon rubber's astounding resistance to cold temperature. Even after being extremely cool by dry ice, the silicon rubber retoins its flexibility with no noticeable effects.

concerns are now giving them away like matchbooks for advertising purposes. Silicones have a natural affinity for glass—they are partly composed of silicon dioxide (sand) which is an important ingredient in glass—which makes them well-suited for glass cleaning tissues.[29]

Since silicone's debut there have been many worthwhile silicone-containing products flooding the market. Top architects are recommending silicone-based, water-repellent treatments for masonry ways. This treatment, dubbed "Stop-all," provides up to ten years protection for cinder block, concrete, plaster, brick, stone, or stucco. It also prevents the formation of the white powder that often disfigures brick, and it prevents muddy water from seeping into the pores, thereby giving the bricks a cleaner appearance.[30] Thomas Jefferson's home and the Field Museum in Chicago are shining testimonials to the coating powers of silicones.[31]

However, this coating protection is not confined to masonry alone. Many paints on the market today have a silicone base. They were basically developed for use on arctic shelters (where they keep off the snow and ice), space heaters, and exhaust manifolds (where they retain their good looks at high temperatures), but they are being used successfully in homes and industries. The silicone additive also increases the ease with which the paint flows. It gives a satin-smooth finish without any betraying brush-marks.[32] After the basement and sides of the house have been protected with silicones, the job can be completed with silicone-coated asbestos shingles that are now being offered by several manufacturers.[33]

The use of silicone as a polish for cars and furniture has gained a well-merited popularity. "Autobrite," one of many brands on the market for automobiles, advertises easier application, longer life, and water-repellency.[34] The time required for polishing a car with a silicone fluid is variously estimated at one-half to one-fourth that required with a good hard wax. It lasts for six months on one application, has a luster equal to that of a hard wax, and bettter resists water and dirt because, unlike wax, there is no softening with heat. The hard glass-like finish even retards water and fingermarks.[35]

Likewise, furniture polish has the same advantages with silicone additives. It gives improved luster, reduces water spotting, and makes a hard wax easier to rub down. The grain of the wood is brought out more distinctly and a curious "releasing" quality prevents dust from sticking to the surface. Once the coating has been applied, a silicone-impregnated dust cloth polishes the furniture as it is dusted. This polish can even be used to minimize rings in a bathtub, or to apply a protective finish to phonograph records.[36]

The first industry to realize the advantages of silicones as release agents was the bread-bakers. "Pen-Glaze" is a silicone coating which bakers use to eliminate greasing and degreasing the pans. Harvard Baking Company of Midland, Michigan, was the testing grounds. They found that it gave easy release of bread for 150 to 200 bakings. Word spread from baker to baker, and now most bakers are taking advantage of it.[37]

Another major use for abhesives, the opposite of adhesives, was opened when a Dow Corning chemist visited one of his friends at the United States Rubber Company plant in Detroit. The rubber company decided to apply a silicone treatment to its tire molds and soon reported that its daily production of scrap tires—tires that stick to the mold and become deformed—had dropped from 1,000 to essentially none.[38]

Dow Corning's "Sylmer" and General Electric's "DeCatex 1107" are being used to effectively water-proof silk, viscose, acetate, cotton, nylon, and even wool and the glass fibers. The silicones are impregnated into the material to invisibly coat each fiber with an impermeable film. They make the material feel softer, smoother, or more resilient, depending upon individual choice, by adding various types and amounts. Any normal staining liquid may be brushed off or blotted up before it soaks in, and practically any spot can be cleaned away with water. Silicones even increase the sewability of the cloth because they lubricate the needle.[39]

These are but a few of the infinite number of uses for silicones. Daily, new uses are being discovered by the scientist and by homeowners. Mrs. Richard L. Talbot found that if silicone lotion was applied to her hands before washing the dishes, she could escape red, irritated, "dishpan hands." It even cleared up her baby's diaper rash. The University of Wisconsin Medical School, upon Mrs. Talbot's suggestion, investigated this use and found that it cleared up 58 of 61 cases of skin irritation that had failed to respond to other therapy. Now the Talbots are in business marketing their discovery.[40]

Future uses for silicones include greaseless frying and cooking. A thin coat of silicone will be applied to pots and pans to eliminate the need for messy grease. The coating will be on the utensils when they are purchased, and after many hours of use a new coat may be easily brushed on at home. Similar coatings will keep ice from clinging to trays, prevent irons from sticking to fabrics, and allow food containers to be drained to the very last drop.[41] One authority looked into his crystal ball and prophesied that "the automobile of 1975 will use silicone rubber for heat-resistant gaskets, wire insulation, and engine block cushions. Silicone oils will be used as brake fluid, as the damping for hydraulic springs, as the lubricant for speedometers and other instruments. Upholstery will be water-proof and stain-proof. Silicone automobile finishes will likely last for the life of the car with no need for waxing and polishing."[42]

Yes, there is a silicone in your future!

[1]"Miracles from Sand," *Newsweek*, XLI (June 1, 1953), 60.
[2]S. L. Bass, "Silicones—A New Continent in the World of Chemistry," *Electrical Engineering*, LXVI (April, 1947), 32.
[3]*Ibid.*
[4]Eugene Rochow, *An Introduction to the Chemistry of the Silicones* (New York: J. Wiley and Sons, 1951), 1.
[5]Complete listing of all of Professor Kipping's papers on silicone research may be found in An *Introduction*, p. 60.
[6]Milton Silverman, "Scientist's Goofiest Discovery," Saturday Evening Post, CCXXVII (February 26, 1955), 36.
[7]*Ibid.*, p. 37.
[8]The Grignard reaction and other chemical processes which may be mentioned later are described fully in *An Introduction*.
[9]Roh Roy McGregor, *Silicones and Their Uses* (New York: McGraw-Hill, 1954), p. 17.
[10]*Ibid.*, pp. 18.
[11]"Newest Synthetic Family," *Business Week*, (March 29, 1947), p. 49.
[12]Silverman, p. 126.
[13]Silverman, p. 126.
[14]*Ibid.*
[15]*Ibid.*, p. 127.
[16]General Electric College Press Section, *Forecasts Indicate Greater Use of Silicones* (New York, 1954), p. 6.
[17]Silverman, p. 35.
[18]*Ibid*, p. 127.
[19]"Miracles From Sand," p. 60.
[20]"Plaskon Eyes Silicones," *Business Week* (September 5, 1953), 70.
[21]"Another Boost for Silicones," *Business Week* (February 3, 1951), 68.
[22]*Forecasts Indicate*, p. 3.
[23]*Ibid.*, p. 4.
[24]"Silicones—A New Continent," p. 32.
[25]*Forecasts Indicate*, p. 4.
[26]"Silicones—A New Continent," p. 32.
[27]*Forecasts Indicate*, p. 6.
[28]"Getting Silicones Started," *Business Week* (April 30, 1949), 84.
[29]M. Gough, "You Should Know About Silicones," *House Beautiful*, XCVII (January, 1955), 66-67.
[30]"Silicones: A New Touch for Daily Life," *Business Week* (January 9, 1953), 134.
[31]*Ibid.*
[32]"Silicones for Waterproofing and Auto-Polishing," *Science Digest*, XXVIII (August, 1950), 94.
[33]McGregor, p. 63.
[34]Gough, p. 70.
[35]"Getting Silicones Started," p. 84.
[36]Silverman, p. 127.
[37]"Silicones Give Wool Fine New Repertory," *Business Week* (April 24, 1954), 32.
[38]"Silicones, Magic Sand with a Thousand Uses," *Reader's Digest*, LXII (February, 1953), 29.
[39]J. Polshek, "What You Should Know About Silicones," *House Beautiful*, XCV (September, 1953), 201.
[40]"Silicones: A New Touch."

An Arab furtively stepped on a scale
Near the end of a lingering day
A counterfeit coin he dropped in the slot
And silently stole a weigh.

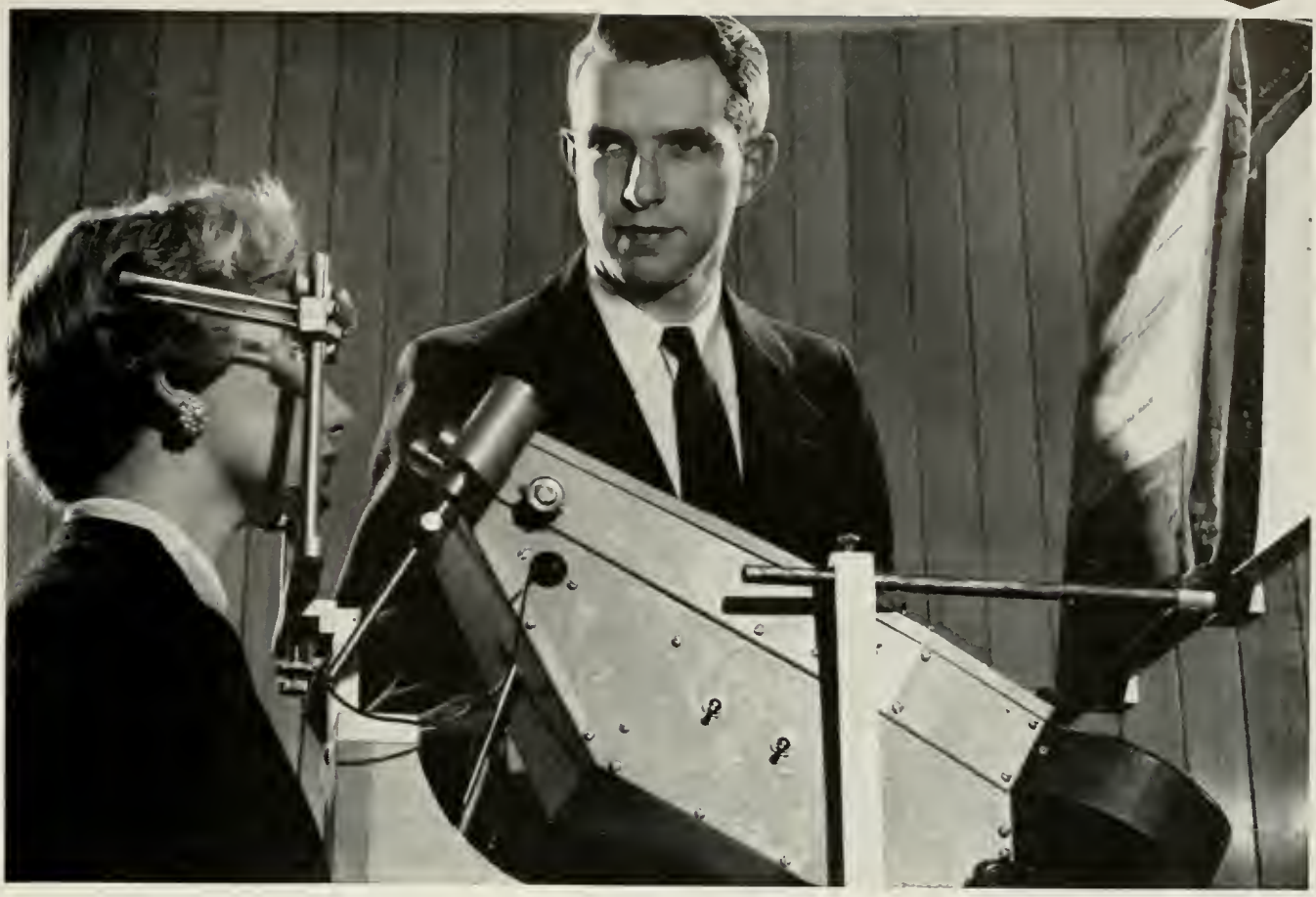
* * *

Then there was the out-of-town student who got thrown out of his apartment when the landlady heard him drop his shoes on the floor twice.

* * *

He: "Whisper those three little words that will make me walk on air."
She: "Go hang yourself."

DOW



MUCH MORE THAN MEETS THE EYE GOES INTO DOW PACKAGE DESIGN

Engineers and ocular cameras, salesmen, lawyers and artists combine talents to produce a unified "sales team" for Dow

Tin cans and tank cars, cardboard cartons and fiber drums, bags and bottles of sundry shapes, carry Dow products to world markets. In addition to quickly describing its contents, each package should speak for the product's quality and should reflect the company which produced it. Dow recently redesigned its packages with these objectives in mind.

Developing effective design while maintaining family resemblance for hundreds of Dow products was not an easy task. The abilities of hundreds of people and many machines were involved. Designers, engineers, salesmen, lawyers and artists all were called upon to contribute their particular knowledge.

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500 Millimicrons

by John Graves, M. E. '58

Waves of a certain length affect the optic nerve of our eye and are called light waves. Just as our ears are sensitive to air waves of certain lengths, so our eyes are sensitive to ether waves of certain lengths. The theory of ether waves was brought about by the facts known of radiation.

We receive heat from the sun by radiation. Since heat is a form of energy produced by the motion of the molecules, waves are set up in the surrounding medium. A scientist, Huygens, advanced the wave theory to account for the transmission of radiant energy. Radiations travel through a vacuum; so he presupposed the existence of a very subtle medium which pervades all space and transmits radiant energy. This medium is called ether. It is supposed to be an invisible fluid, so very rare that it cannot be weighed or measured; it easily penetrates intermolecular spaces.

As early as 1678, Huygens proposed his wave theory of light and suggested that light waves are ether waves. However, the theory was opposed to such an extent that it was delayed one hundred years. His theory was opposed by Sir Isaac Newton's corpuscular theory. According to the corpuscular theory, or the emission theory, streams of extremely small particles of corpuscles are emitted by luminous bodies. Such corpuscles produce the sensation of light when they enter the eye and stimulate the optic nerve.

When Huygens assumed the existence of the ether as a medium through which light waves are transmitted, men of the eighteenth century found it difficult to accept such a theory. It is difficult to try to picture a medium which we cannot see, feel, smell, or taste. We find it hard to imagine a weightless fluid so subtle that it slides in between the molecules and pervades all space, even that of a vacuum. However, the theory has been accepted because it is difficult to explain some of the phenomena of light by the corpuscular theory.

In 1864, James Clerk-Maxwell, one of the greatest of modern physicists, suggested that light has its origin in ether waves set up by electrical disturbances. His elestromagnetic theory of light has been commonly accepted, especially since the experiments of Heinrich Hertz seem to confirm Maxwll's suggestion. It is possible then, that light waves are ether waves which have their origin in the vibrations of electrically charged particles which compose the atoms themselves.

Still more recently the quantum theory of light has been proposed. Max Planck of Berlin suggested in 1900 that light is transmitted in small bundles or packets of energy called photons, or quanta of light. Einstein's experiments confirm this theory, and his theory of relativity has made many scientists skeptical of the existence of the ether. To explain all the various phenomena of light it seems to be necessary to use the quantum theory and the wave theory.

Light waves differ in several ways from sound waves: (1) Light waves travel through a vacuum, while sound waves do not. Hence, light waves are ether waves, but sound waves must be transmitted by ordinary matter. (2) Light waves are transverce, while sound waves are longitudinal. (3) Sound waves vary in length from 1 cm. to nearly 21 meters, while light waves range from 0.000039 cm. to only 0.000081 cm. in length. (4) Light waves travel in straight lines, but sound waves bend around corners readily. We can hear a person who stands around the corner from us, but we cannot see him. (5) Light travels so rapidly it is considered instantaneous for short distances. The speed of sound is very slow compared to that of light. In one second light travels a distance equal to more than seven times around the earth at the equator.

There are two sources of light, natural and artificial. Nearly all the natural light that we receive comes from the sun. However, the distant stars furnish us with some light. Some of the stars are larger than our sun and give off more light, but they are so far away that we receive only a tiny fraction of the light that they emit. The moon-light is caused by the reflection of the sunlight off the moon. It has been established that the giant star Betelgeuse has a diameter of about 235,000,000 miles, but the sun is only 866,000 miles in diameter.

There are several ways of producing artificial light, Friction may be used to heat objects until they glow. When gas, oil, or other fuel burns light is produced. Electricity is used to heat tungsten wire to incandescence, or until they glow. Sometimes burning fuel is used to head objects to incandescence.

Now we reach the problem of distinguishing between luminous and illuminated objects. If a platinum wire was to be heated, the ether waves that are set up become shorter and shorter as the temperature rises. The wire soon begins to glow, or it becomes incandescent. It is a luminous body, visible on account of its own light. An object that gives off light on account of the energy of its own oscillatory particles is said to be luminous. The stars are luminous and emit light.

Just as sound and heat are reflected, so light waves may be turned back from the surface of bodies. Mirrors reflect light that is received from some other source. A body that merely reflects light which it has received is an illuminated body. The moon is an excellent example. Like a huge mirror, it reflects light which it receives from the sun. Some of the planets may be hot enough to be luminous, but most of them are illuminated bodies, reflecting light received from other sources.

What happens when light waves fall upon the glass of our windows or upon the surface of the water? Part of the light is absorbed by the medium itself. The three charactreistics of light waves, reflection, absorption, and transmission can be explained as follows.

Smooth bodies of water have been used as a reflector of light from the earliest times. The panes of glass from the window of a distant house reflect light to us. However, if the glass is re-

Cliff Litherland asks:

Would I have varied assignments at Du Pont—or would I specialize technically?

CLIFFORD LITHERLAND received a B.A. degree from Rice Institute last year, and is now working for a B.S. in Chemical Engineering. He is Business Manager of "*The Rice Engineer*," and Vice-President of the fifth-year class at Rice. By asking questions of prospective employers, Cliff is trying to get information that will help him make the best use of his training in the years ahead.

ARTHUR I. MENDOLIA was graduated from Case Institute in June 1941 and started work with the Du Pont Company that same month. In addition to handling challenging assignments at work, he also enjoys some interesting hobbies. Although he makes no claims personally, he's classed as a minor authority on golf and hi-fi music. Mr. Mendolia is Assistant Director of Research for Du Pont's *Electrochemicals Dept.*

Arthur Mendolia answers:

Well, Cliff, I'd say the answer to that question depends largely on your own preferences. In a company the size of Du Pont there are opportunities for growth along either line.

In my own case, I've followed the route of diversification—and I think you'll find that's the general procedure when a fellow is interested in administrative work.

For example, after graduation I started work in the research lab at Du Pont's Niagara Falls plant. That was followed by two years of process improvement work, and a stretch as assistant supervisor over one of the plant areas. Next, I spent a few years in liaison on the design and construction of our first full-scale plant for making nylon intermediates from furfural. Then, I had assignments on "plant start up," and production supervision before I was given my present post. I was made Assistant Director of Research for Du Pont's *Electrochemicals Department* last August.

You see, variety of assignments means contact with new men and with constantly changing problems. That keeps interest alive. It leads to growth, too, because it provides a broad base of experience for future responsibilities.

On the other hand, some fellows prefer to become specialists in a particular field—and Du Pont has many opportunities for that type of professional growth, too. In our research, development and design groups we have experts on distillation, mass transfer, thermodynamics—and most anything else you'd care to mention in the field of engineering. These men are respected throughout the whole company for their technical knowledge.

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moved, we see what appears to be a dark opening. Also, highly polished metals make good reflectors of light. Dark colored objects are good absorbers of light. Black objects absorb all the light that is cast upon them. When the vertical rays of the sun strike a body of water, most of their light is either absorbed or transmitted. More of the rays are reflected when they strike the water at an oblique angle. Air, glass, and water transmit light readily. They are said to be transparent. Transparent bodies transmit so much light that it is easy to distinguish objects through them. Objects which transmit light but are unable to see through are translucent. Objects which do not transmit light at all are opaque.

Now the question is, how fast does light travel? Light travels so fast that it appears to be instantaneous. In fact, Galileo concluded that no time at all was required for light to travel from one place to another. His conclusion was accepted until a method of measuring light velocity was found.

The first experiment for measuring the velocity of light was performed by a Danish astronomer, Roemer. His experiment had to do with one of Jupiter's statelites and the position of the earth. First when the earth was on the side of the sun nearest to Jupiter and six months later when the earth was on the opposite side of the sun. In doing this he found that the eclipse occurred 16 min. 36 sec. later than the first time, and that he was 186,000,000 miles farther from Jupiter than before. So he calculated that if light travels 186,000,000 miles in 996 sec., then the velocity of light must be a little more than 186,000 miles per second.

There were other methods of finding the velocity of light, also. One of which was by using a mile-long vacuum tube. The vacuum tube was used to prevent errors due to haze and to varying density of air. A light was reflected back and forth ten times in this tube. The value obtained by this method is 186,285 miles per second, which is not believed to be more than one mile in error. The velocity of light in water is about three-fourths as great as in air. In ordinary glass it is about two-thirds as great. Light travels slightly faster in a vacuum than in air.

If a beam of sunlight was permitted to fall upon a glass prism through a narrow slit in a window shade, we could see a band of seven colors. Such a band of colors is called a solar spectrum. This shows that sunlight is complex and that it is composed of several colors; it is polychromatic light. If light consists of only one color, it is said to be monochromatic.

Such a method of analyzing complex light, or separating it into its colors is called dispersion of light. Such dispersion is due to the fact that some colors are refracted more than others as they pass through a glass prism. Violet light is refracted more than any other color, since it has the shortest wave length. Red rays are bent least in passing through a prism; they are the longest of the light waves. The other colors lie between the red and the violet. The other colors in order of refraction are, indigo, blue, green, yellow, and orange. The rainbow is a beautiful example of a solar spectrum cast across the sky by the dispersal of sunlight from drops of falling water.

Just as the pitch of sound depends upon the number of vibrations which reach the ear per second, so the color of light depends upon the number of vibrations which reach the eye per second. Color bears the same relation to light that pitch does to sound. When one end of an iron poker is held in a fire, the electrically charged particles in its atoms oscillate faster and faster as the temperature rises. Soon the vibration rate becomes fast enough to give off waves to which the eye is sensitive. The first color which the eye can detect is a very dark red. To produce this dark red color, the vibrations must be so rapid that the wave length produced is only 0.00081 mm. in length. Longer waves than this affect our temperature sense and are known as infra-red rays, but the eye is not sensitive to them.

It is difficult for pupils to think of color as a property of light waves rather than of objects. For example, we have a piece of cloth which we say is blue, but if we hold it in the red portion of a solar spectrum in a darkened room, we find that it seems black. If we put a piece of red cloth in the blue portion of such a spectrum, it will also appear black. What do we mean by saying that an object is blue? We mean that it absorbs all the light except blue, but it reflects the blue light to the eye.

From these observations, we must conclude that the color of an opaque object depends upon: (a) the color of the light that it can reflect; (b) the color of the light that shines upon it. Strictly speaking, color is a property of light waves that is dependent entirely upon their length.

Artificial lights are likely to be deficient in certain colors, particularly in the blue and the violet. The mercury vapor lamp, which is widely used by photographers, is deficient in red and yellow rays. A person sitting under the rays of such a lamp loses his natural color.

The color of transparent objects depends upon the color of the light waves which they transmit. Ordinary window glass, which transmits all colors, is said to be colorless. Red glass absorbs all colors but red, which it transmits. The stars of the United States flag would appear red on a black field, if viewed through red glass.

If compound, or polpchromatic, light can be analyzed into its simple colors, it seems reasonable to suspect that one can combine simple colors to form compound light. This can be done in two ways. (1) If we place a second prism in the solar spectrum formed by a prism, the different colors will recombine to produce white light. Other colors may be compounded in the same manner. (2) If we have given a disc which has the spectral colors painted upon it, we may combine the colors by rotating the disc rapidly. Since we have duration of vision, the light from one color forms an image which persists on the retina until each of the other colors in turn has been reflected to the eye.

It is of interest to inquire how light waves of different length affect the eye in such a manner that we see different colors. The most generally accepted theory of color sensation was proposed by Dr. Thomas Young and later elaborated by Helmholtz. It is based upon the Young-Helmholtz color theory, the retina of the eye is provided with three sets of nerves, each set being sensitive to one of the three primary colors red, green or bluish-violet.

Now that we know that the sun's rays are separated into colors by a prism to form a solar spectrum, we should know the different kinds of spectra. Light from other sources may be analyzed in the same manner. There are three kinds of spectra:

(1) A platinum wire held in the colorless flame of a burner produces a spectrum that consists of an unbroken band of seven colors. Since the seven colors form one unbroken band, such a spectrum is said to be continuous. Continuous spectra are produced by incandescent solids, liquids, and dense gases.

(2) Another kind of spectra is the discontinuous spectra. If a platinum wire was dipped into a solution of common salt, or sodium chloride, and then held in the colorless flame of a burner surrounded by a piece of metal in which a narrow slit has been cut. When the light coming through this slit falls upon a prism, the spectrum which it forms on a screen consists of a bright yellow single line. Since this bright line breaks the continuity of the band of colors, such bright-line spectra are known as discontinuous spectra.

(3, We may produce bright-light spectra with luminous sodium vapor just as before, and then place an iron pan containing sodium chloride between the slit and the prism. When the pan is heated enough to vaporize the sodium chloride, but not hot enough to make it luminous, a dark line appears in the

spectrum where the yellow line had before. The yellow light waves have been absorbed by the sodium vapor. Such spectra are called dark-line, or absorptive spectra. Gases or vapors can absorb light waves of the same length they would produce themselves, if they were heated to luminosity. For example, luminous sodium vapor gives bright yellow light waves. Non-luminous sodium vapor absorbs yellow light waves.

When the sun shines upon drops of falling water a solar spectrum may be formed. Water disperses light in the same manner as a prism, but reflection and refraction of light are also important in forming the rainbow. As a beam of sunlight enters a drop of water it is refracted; dispersal also occurs. The red ray suffers total reflection the same as the violet ray. When they leave the drop both rays are again refracted. The other colors are formed by drops between the red and violet rays.

If we could look at the end of a beam of light, we should probably see some of its transverse waves vibrating from side to side, some up and down, and others at various other angles. Certain crystals, tourmaline for example, transmit only those waves which are vibrating in the same plane as the axis of the crystal. When light passes through such a crystal, we have polarized light. Polarized lenses are used widely by automobile manufacturers for headlights because the lenses stop the excessive glare from the lights. This enables people to see the sides of the roads better while driving at night.

Although a great deal is known about light waves and their characteristics, it is still a phenomena in the field of physics. There is still room for advancement and improvement in the field of light as in any other field of physics.

A woman saw an elephant in her yard and immediately called the police. "Chief," she said, "there's a queer looking animal out here in my back yard. He's picking flowers with his tail."

"Yes," said the sergeant, "and what does he do with them after he's picked 'em?"

"Never mind," was the answer, "you wouldn't believe me if I told you."

* * *

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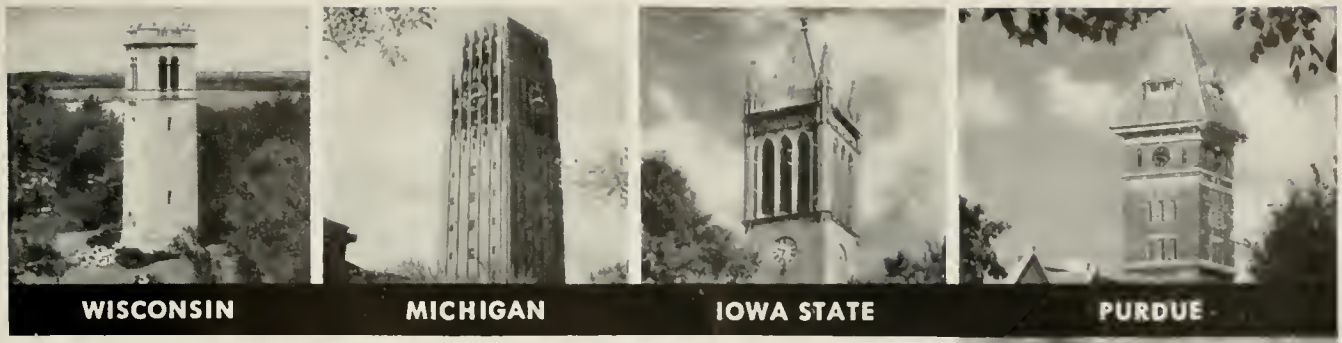

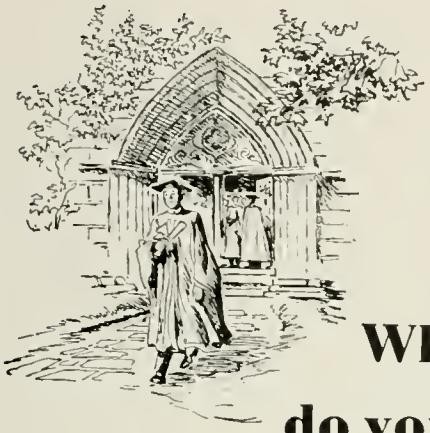

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From Push to Swoosh—

by ROBERT J. MARKS, Aero. E. '58

Ever since man has been on this earth, he has had dreams of being able to fly. This has been shown to us in Greek mythology by the famous flying horse, Pegasus. The Egyptians' sun god was a falcon. In Nordic legend, the Valkries rode winged horses and the Arabs had their stories of magic flying carpets. Several legends of man's early attempts to fly date as far back as 2000 B. C.

Through the years, men had many ideas of how to fly. The first really scientific step taken in aviation was by Archimedes when he established his law stating that floating bodies displace an equal volume of water. This principle is also extended to cover air. In the 1200's Roger Bacon published his book *Secrets of Art and Nature* and in it discussed a flying machine that could be made by taking a large hollow copper globe and filling it with "liquid fire." His definitions of this liquid fire were very vague and nothing ever became of his theory. It is recorded in Chinese history that balloons were sent up during the coronation of the emperor Fo Kien, but there is no real proof of this. Then, for over two centuries nothing was said or done about flying. Then, Lenardo Da Vinci revived the subject. He studied birds and their flight and in 1505 published a treatise on the flight of birds. Da Vinci formulated the principle that "An object offers as much resistance to the air as the air does to the object." Centuries later there were still many experimenters in flight that did not realize this important fact. He made many drawings of flying machines, many of which were patterned after birds. It is entirely possible that Da Vinci might have made some type of successful aircraft had he possessed a light-weight and powerful engine of some type. He even made sketches of a primitive parachute which he called a "fall breaker." A hundred years later, in 1648, Bishop John Wilkins published a treatise called *The Art of Flying* which was mostly pure nonsense. In 1670, a Jesuit priest, Francesco De Lana, proposed that a wicker basket be suspended from four large copper balls that had the air pumped out of them. He did not build the machine and therefore did not find out that the balls would collapse from atmospheric pressure. His reason, and very true, was that it would make wars even more horrible than they were at the time. Giovanni Borelli, in a treatise written in 1680, told the findings of his studies of the movements of animals. He showed that man is the weakest of all creatures for his comparative size. He pointed out that, even if artifical wings were contrived, a man would not have the strength to support his body in flight and that birds are definitely stronger when compared with man. Recent experiments have shown us that birds can draw on their reserve energy more so than any other creature on this earth.

It was because of Evangelista Torricelli's discovery in 1643 that air is a mixture of gases that really started the era of balloons. Because of his discovery, a search began in the 1750's for a gas that is lighter than air. In 1776, Henry Cavendish discovered hydrogen. Joseph Black, a Scottish professor, wrote his opinion that animal bladders filled with this gas would float. It was not until an experiment was made in 1771 that this statement was proven to be correct.

The first successful balloon was made because of a mistaken idea. The two Montgolfier brothers, Jacques and Joseph, saw the similarity between clouds and smoke and thought that smoke in light containers would float. As they were in the paper-making business, it was quite natural that their first containers were paper bags. With this arrangement, partial success was achieved on their indoor experiments. This prompted them to take their experiments outdoors. On June 5, 1783, they finally succeeded in sending a balloon up to about 1,000 feet. They then made a balloon out of silk which greatly exceeded the height and distance previously reached.

Their experiments attracted such attention that, in Paris, the Robert brothers made a balloon out of silk, under the direction of the famed physicist, J. A. C. Charles. This balloon was filled with hydrogen and on August 27, 1783, rose to a height of 3,000 feet and traveled over fifteen miles, all during a pouring rain.

The next Montgolfier balloon that went up carried animals as passengers. The ascent was made in Versailles in the presence of Louis XVI and his court. The animals, a rooster, a duck, and a sheep, were placed in a gondola attached to the bottom of the balloon. Louis liked the demonstration and wanted to send up a condemned criminal as the first man but the court historian, Jean Francois Pilâtre de Rosier, saw a chance to get his name written in history and begged the king to let him go up. This historic balloon was made of treated linen and was forty-five feet diameter and seventy five feet high. During their experimenting, the brothers discovered that it was the hot air that made the balloon rise and not the smoke, so they placed a brass pan under the neck of the balloon that was filled with wool and straw which was burned in the air, thereby keeping the balloon in the air for a longer period of time. With this arrangement, De Rozier and a French courtier, the Marquis D'Arlandes, made a flight which lasted over twenty-five minutes and carried them over the city.

The Montgolfiers' rival, Charles, made a flight ten days later in the first hydrogen balloon. It stayed up for over two hours and flew over twenty-five miles from Paris. After this, the balloon craze spread like wildfire. People were even paying to go for rides in balloons. Scientific work with balloons also continued. On November 13, 1784, the first recordings of air pressure from great heights was made. On January 17, 1785, the first balloon crossing of the English Channel was made. The first

balloon flight in America was made on January 9, 1793, in Philadelphia by Francois Blanchard, one of the men who had crossed the English Channel. The first balloon casualty was when De Rozier's hydrogen balloon exploded as he was trying to cross the English Channel. He was killed immediately. After this incident, balloons were filled with coal gas, which is cheaper and safer.

Even from the start, many fliers tried to devise some way to control the direction of the flight. Along with the growth of the balloon the parachute was also developed. Sebastian Lenoramando, a Fernch physicist, is given credit for inventing the parachute. The first known jump made with a parachute was on October 22, 1797, and was made by Andre Jacques Garnerin over the city of Paris. Military uses were then devised for balloons during the Napoleonic Wars. Balloons were also used in the Civil War.

Because of the boldness of many of the aeronauts, there were many records made. Charles Green, the first man to use coal gas, flew 500 miles in eighteen hours in the year of 1836. In a balloon race in 1906, Alan R. Hawley stayed up for more than forty-six hours and traveled 1,355 miles. In 1927, Capt. Hawthorne C. Gray of the United States Army set the altitude record which still stands—42,470 feet in an open gondola. He was found dead in the gondola when the balloon came down, but the altitude was registered on his barometer. In later years new records were made in closed-cabin balloons. A height of 55,500 feet was made in the year of 1936. In 1935 the National Geographic Society and the Army Air Corps collaborated and sent a balloon, piloted by Capts. A. W. Stevens and O. A. Anderson, up to an altitude of 72,395 feet—a record that stood until the days of jet-powered supersonic flight.

Henri Giffard is the man accredited with the building of the first airship. He took James Watts' steam engine and combined it with Jean Meusiner's propeller and made a 144-foot airship. On September 24, 1852, he flew the ship from Paris to Elancourt at a speed of five miles per hour. This was the first completely-on-purpose flight made. Dirigible flight was brought to its modern level by a German, Count Ferdinand Von Zeppelin. The first successful Zeppelin was flown in the year of 1900. It weighed 25,000 pounds, including passengers and freight, and was driven at a speed of seventeen miles per hour by two sixteen-horsepower motors. In 1915, Zeppelin merged his company with that of his rivals, the Scheutte-Lanz, and proceeded to make Super-Zeppelins. One of these super airships, the R-34, was the first airship to cross the Atlantic Ocean. His most famous airship, and also the largest, The Hindenburg measured 811 feet, weighed 220 tons and had a volume of seven million cubic feet. It had a top speed of eighty-four miles per hour delivered by four 4440-horsepower diesel engines. Its cruising range was 8,750 miles. After seventeen trans-Atlantic flights, it crashed in flames at Lakehurst, New Jersey, killing 33 of its 105 passengers and crew.

The only airships in use right now are blimps. They are used mainly for advertising purposes and for observation purposes by the army and navy.

During the 1800's, two schools of thought were developed. One school of thought was that man could fly without any outside source of power. The other school of thought was that man would be able to fly in the future if some source of power were found. They were both partially right, but it was the work of the former group that started the progress of glider flight.

Otto Lilienthal is the man given credit for the first really successful glider flight. It was made from the top of a hill in Anklan, Germany in 1891. He made more than 2,000 glider flights with some of his longest being over 900 feet. When he was killed in a crash in 1896, he left his notes open for the public to use and benefit from. Percy Pilcher of England added much to Lilienthal's notes until he was also killed in a crash in 1899. After these two pioneers died, the spotlight on glider achievement was shifted to the United States.

Here, the acknowledged leader of aviation research was Octave Chanute. He made many flights at the sand dunes on Lake Michigan near Chicago. Chanute learned just about all that there was to know about gliding. He discovered that the most efficient gliders were biplanes. Since his time, most of the work done on gliders has been refinements in design but not new innovations. One of the longest glider flights made at the time was by his assistant, A. M. Herring. He made a flight at the dunes that lasted forty-eight seconds and traveled 927 feet.

The Wright brothers were also experimenting with gliders, and it was a great boon to them when Chanute turned all of his notes over to the brothers thus saving them months of time and effort. The brothers built their first great contribution to aviation—the wind tunnel. After much experimenting with different types of wings, they selected the one that had shown the best results and made a full-size plane using this type of wing. This time the brothers met with success. They made more than 1,000 glides that summer with some of them lasting longer than a minute and traveling more than 600 feet.

It was natural that the next step to take after gliders was some type of powered flight. It was, therefore, due to the Wright brothers' success with gliders that they became pioneers in powered flight.

On the morning of December 17, 1903, the Wright brothers decided that the weather conditions were just right at Kitty Hawk, North Carolina, and they proceeded to ready their queer-looking flying machine. It certainly was an odd piece of machinery that looked like a large kite. It had a body like a piano crate with most of the slats removed. The two graceful wings were tangled up midst the mess of bracing wires. There were two rudders, one vertical and in the rear for turning; the other, horizontal and held in front, to raise or lower the nose of the ship. In the center, a four cylinder gas motor was connected to two propellers. The plane was to land on two curved skids which were to keep the plane from overturning. With one of the brothers on board, it weighed slightly more than 750 pounds. Orville made the first trial which did get off the ground but was only up for twelve seconds and flew about forty feet. After two more unsuccessful trials by Orville, Wilbur took over and on his first trial achieved success. He flew a distance of 852 feet, stayed up fifty-nine seconds, and flew at a speed of about eleven miles per hour.

This first flight was not just a mad leap into space but had been planned for over one-hundred years previous and by many men. One man who possessed much foresight in this field was George Cayley of England. In his book, *On Aerial Navigation*, he stated that a solution to the problem of flight would be to make "a surface support a given weight by application of power to the resistance of air." He proved that he knew what he was talking about by making many successful model gliders. He was hampered only in the fact that he had no light-weight source of power as he was making his experiments in the year of 1809.

In 1843, Samuel Henson obtained an English patent on an "aerial steam carriage" of astoundingly modern design. It was a monoplane with a wing span of 150 feet and included movable elevator and vertical rudder! Substituting a gas engine for the steam and you have, in 1843, plans for an airplane containing features of modern aircraft up until the time of jets.

Modelmakers were so active that in the year of 1866 the Aeronautical Society of Great Britain was founded. modelmaking was being carried on in France, Germany, Italy, Austria, and the United States.

In the United States the most scientific work being carried on with models was done by Samuel P. Langley, direc

tor of the Smithsonian Institution. He developed models to such a degree of control that he could get them to perform three complete circles in flight. Langley came very close to building the first airplane capable of carrying man in powered flight. He built a machine with a fifty-two horsepower engine and on October 7, 1903, tried to catapult it from a houseboat on the Potomac River, but it failed to fly. After much repair, he made another attempt on December 8th with the same result. Nine days later the Wright brothers achieved success at Kitty Hawk. Whether it crashed because of flaws in the design or because it got caught on the supports of the catapult during both launchings is still a subject for a heated debate between students of aeronautical history. The first airplane fatality occurred in the year of 1907. Orville Wright was demonstrating one of his planes to the army at Fort Meyer, Virginia, when one of the propellers caught in a loose rudder wire and crashed, killing the one passenger, Lieut. Thomas E. Selfridge. In 1908, the army accepted the Wright brothers' plane, making it the first government-owned plane in the world.

The first woman ever to fly in a plane was the wife of a captain in the United States Army, Capt. De Ralph C. Van Deman. She flew as a passenger with Orville Wright on a test flight in 1909

The idea of crossing the English Channel was thought to be a great test for the fliers of the 1900's and seemed so difficult that the London *Daily Mail* offered a £5,000 prize for the first air crossing. On July 24, 1909, the flight was made by Louis Bleriot, who flew from Calais to Dover in twenty-five minutes. The flight was made in a 485 pound monoplane powered by a three-cylinder Anzani engine. The twenty-five horsepower engine weighed 143 pounds, delivered 1600 revolutions per minute and had a piston displacement of 205 cubic inches. It pulled the plane along at a speed of forty-two miles per hour.

The history of aviation would never be complete without some mention of Glen Curtiss. To enumerate his many contributions to aviation would be a complete story in itself, but it be said that he established many flying records, aided the army and navy in establishing their air forces, and, in general, aided aviation in many ways.

Another colorful character associated with making people air-minded was Lincoln Beachy, one of the most famous barnstormers in history. In his lifetime he made many tours with the Curtiss exhibition troupe. He was also the first American flier to loop-the-loop. He died on March 14, 1915, while stunt flying at the Panama-Pacific International Exposition at San Francisco.

The airplane was never so greatly improved as it was during the years of 1914 to 1918, during the first World War. The fuselage was covered, the tail assembly was completed, undercarriage landing gear was added, the efficiency of the airframe had been improved since Kitty Hawk about 200 per cent, the average speed had reached 150 miles per hour, and the engine now weighed about 1.9 pounds per horsepower. The attitude of the aviators in the war was that of ancient knights entering a joust or tournament. These light-hearted aviators fought for personal glory—the last of romanticists in war. Some of the aces in the war were Billy Bishop and Edward Mannock for England, Bob A. Little and Eddie Rickenbacher for America, and Baron Manfred Von Richtofen and Ernst Udet for Germany.

At the end of the war, there were many fliers who did not want to give up flying and therefore made attempts at many records. The first government mail service was started in May, 1918, between Washington, Philadelphia, and New York. The first scheduled airline in the United States was established between Key West, Florida and Havana, Cuba in 1920. Soon after the war, Commander Albert Cushing Read of the U. S. Navy, and his five-man crew took off to make an attempt to fly across the Atlantic and in 1919, succeeded in doing so. The flight took fifteen days and covered 4,500 miles. One month after this cautious Navy flight, two fliers took off and flew non-stop to Europe. Pilot John Alcock and navigator Arthur Witten Brown took off from Newfoundland on June 14th and landed in Ireland sixteen hours and twelve minutes later. They averaged 120 miles per hour for the 1,960 mile trip. In November, 1919, three flights were made from England to India. The same month, a flight was made from England to Australia, 11,130 miles, in 124 hours. In 1920, Lieut. C. C. Mosely won the Pultizer air race with an average of 178 miles per hour. Two years later, Gen. Billy Mitchell won the same race averaging 224½ miles per hour. That same year, 1922, Lieut. O. G. Kelly and J. A. MacReady set an endurance record by staying up for thirty-five hours and fifteen minutes. The following year, they flew the first non-stop flight across the continent, in twenty-six hours and fifty minutes. On July 3, 1924 Russell L. Maugham flew cross-continent solo in twenty-one hours and forty and one-half minutes.

In 1922 the U. S. Navy took a big step when they put a roof on the cruiser *Jupiter* and made the first aircraft carrier. This ship was renamed the *Langley*. In the following year, work was begun on converting two more battle cruisers. When these were finished in 1927 they became the *Lexington* and the *Saratoga*.

In the year 1924 preparations were made for the first attempt to fly around the world. The four planes making the trip took off from Santa Monica, Calif., on March 17th. Two of them landed in Washington, D. C. 175 days later. The flight covered 25,000 miles and the two ships which finished consumed 19,200 gallons of gasoline and 4,800 quarts of oil in a total of 320 hours and 19 minutes flying time.

Another great not to be forgotten in the history of aviation is Charles A. Lindbergh. Probably he is best known for making the first solo flight from the U. S. to Paris. He accomplished this flight of 3,600 miles in 33½ hours.

On the eve of World War II many impressive records had been made. A speed record of 469 miles per hour was set by a German pursuit plane. The record for non-stop flight was then the impressive figure of 7,150 miles. Airlanes recorded an impressive figure of 73,267 miles. Planes had also reached the altitude of 41,794 feet and were still climbing.

It is doubtful if the airplane was of any great importance in the first World War, but it was very definitely a deciding factor in World War II.

A few weeks before the invasion of Poland by Germany, the Germans made the first jet flight in a Heinkel He-178 with a Heinkel S3B turbojet. The idea of jet flight had to be abandoned by the Germans at that time because of limited production capacities of their country. They decided to concentrate their efforts on single-seat dive bombers to put across their "lightning war" or *blitzkrieg*. The Germans were soon pushed back by the English because of the superior air power of the British.

The British planes and men were greatly outnumbered but in this sort of fighting they had the advantage. Their talent for producing great pilots and faster planes soon forced the Germans to back away from daylight raids. The development of 100-octane gasoline also gave their planes much more speed and power than the Germans could boast. The fact that the Germans could not capture the Baku oil fields in Russia or the Arabian oil fields in Africa led to a shortage of gasoline which in turn grounded most of the German air force. This fact is thought to be very decisive in our victory over Hitler.

Meanwhile, the United States was struck a crushing blow when, on December 7, 1941, Japan attacked Pearl Harbor. This threw America into one of the most bloody wars in history. Our airplane production was pushed up ahead of everything else so that we could catch up to the progress that the Germans had

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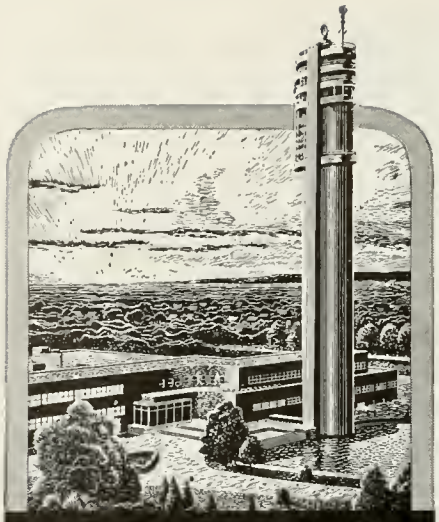

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made. We concentrated on the fighter and the dive bomber of which they had so many; but from the first, the U. S. high command was thinking of long-range high-altitude bombers. Generally speaking, the British preferred what is called saturation bombing—which means just what it says. The whole area is simply saturated with bombs. American bombers, on the other hand, favored precision, pin-point, or strategic bombing, with the bombs dropped on definite targets. In this manner, most of the key German industries were put out of commission.

On April 18, 1942, Col. James Doolittle made a vast sweeping raid on Tokyo, Kobe, and Osaka. The losses were high and the military results negligible, but the main object of the raid was accomplished—to boost American morale and to cause the Japanese to lose their treasurer "face."

Toward the end of the war, thousand-plane raids were fairly common, including 600 B-29's. The Japanese war machine fell apart under such pounding. In July, one month after Germany surrendered (June 8, 1945), Japan sued for peace. The Allies asked for unconditional surrender but the Emperor would not accept this. Then, on August 6, 1945, an airplane was used to drop the most cruel weapon man has ever conceived—the A-bomb. More than 60,000 persons in the city were killed, more than four square miles burned out, 62,000 of the 80,000 homes were flattened—all from one bomb! The Atomic Age had begun with foreboding and dread. But this was not the end. On August 9th, the seaport of Nagasaki was hit with another A-bomb and the result was the same. The following day the Japanese government sued for unconditional surrender.

The evolutionary chain of gradual improvements in the airplane was broken with the coming of jets and rockets. A jet or rocket works on the principle of Newton's third law of motion, "For every action there is a reaction." The simplist application of this principle is seen when air escapes from the open neck of a balloon. It isn't the force of the air escaping that drives the balloon but the pressure set up against the closed end of the balloon. The big difference between rockets and jets is, a jet must have a place for taking air in at the front and for expelling gases at the rear, while a rocket must carry its own fuel, as a jet does, and also its own oxygen as rockets must fly where the air is very thin, or, at least theoretically, where there is no air at all.

The first jet flown in the U. S. were flown in 1942. They achieved speeds of around 600 miles per hour. Since the speed of sound is 780 miles per hour, at sea level, the designers began to dream of supersonic flight. The first such flight was made on October 14, 1947 by Charles Yeager in the Bell XS1, a rocket ship. It flew at speeds of more than 1,000 miles per hour. In the meantime, the U. S. Air Force had enough Lockheed P-80 Shooting Stars to start training squadrons of jet pilots. In June, 1951, a Douglas Skyrocket, an experimental rocket plane, set world records for speed (1,238 mph) and altitude (70,000 feet).

The British were also early in their jet development, having flown their first jet on May 15, 1941. Although the Germans actually had a jet plane in the air earlier, the engine used was a type shortly abandoned, and therefore the British hold the claim of having the first *successful* airplane to use a gas turbine internal-combustion engine. The British also hold the distinction of having made the first jet airliner in the year of 1952.

As was stated previously, the Germans were the first ones to fly a jet plane. This was done on August 27, 1939. All through the war the Germans were doing some work on jets, but most of their time was side-tracked because of the need for other planes in the war. Towards the end of the war, however, they managed to bring some of their jets into action; and if the war had lasted any longer, the Allied supremacy in the air would have been a questionable thing.

Robot planes, guided from aircraft carriers to Communist targets in Korea entirely by electronics, were introduced by the U.S. Navy late in 1952. On the basis of their experiments with this type of aircraft, the Navy later predicted that robot bombers carrying atomic bombs could conceivably hit any target in the world.

The U.S. was not the only one with airpower in Korea as they were met by Russian MIG's. When one of them was shot down in 1951 the world knew that the Soviet Union had a jet fighter that was second to none.

Thus, in the short fifty-odd years since the Wright brothers flew at Kitty Hawk, man has made the world seem even smaller. Powered flight has brought about more changes in a man's lifetime and has more far-reaching results economically and socially than possibly any other event in the history of the world. Even nearer draws the day when an atomic-powered plane will be able to circle the earth in a day. For good or evil, man has added another dimension to his travels and by changing our concepts of time and distance, aviation has changed man's relations to the sphere on which he lives. This is an era in which, literally, "the sky's the limit."

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Above . . . 500 Megacycles

by David L. Komyathy, E. E. '57

Microwaves were the first-made radio waves; these waves were originally made by Heinrich Hertz, in 1888. Hertz's waves were two feet long with a frequency of 500 megacycles. (Modern microwaves are in the range of one-quarter of an inch to two feet long). It is interesting to note that while the first radio waves were microwaves, it wasn't until over sixty years later that microwaves were considered worth anything in radio. The physicists and engineers who deevloped from Hertz's discoveries the beginning of radio went quickly from microwaves to longer wavelengths. The reasons for this were that microwaves could be transmitted only to the horizon and it was very much harder to generate large powers at the microwave lengths than at long wave lengths.

In order to understand microwaves we must visualize their lengths. The behaviour of waves is governed by their size in relation to the dimensions of things with which they interact. Light waves are so small that almost any object we think of is large in comparison. Therefore most objects cast a distinct shadow. The waves of a broadcast radio are about a quarter of a mile long. They will flow around a small hill casting very little shadow. Because the transmitting antenna which sends out these waves is small compared to the wave length the waves are transmitted in all directionse; it takes an antenna many wavelengths in size to focus wavcs. Microwaves, however lie in the range of most common objects. With a small wire microwaves can be broadcast in all directions; with the dishpans, as the reflectors are called, the microwaves can be focused in a narrow beam.

Since these waves are moving at 186,000 miles a second, one may wonder how they can be measured. The method used is a simple one which was developed by Hertz. The waves are reflected straight back and standing waves are produced. A quarter of a wave length from the surface the crest of the reflected waves meets the crest of the incoming waves. Here the combined crests give a strong signal. Half a wavelength away the crest of a reflected wave coincides with the trough ot the incoming wave producing a weak signal if any at all. By determining with a detector where these positions are the wavelengths can be easily measured. Standing wave measurements are used in developing devices which are meant to absorb instead of reflect microwaves.

Microwaves are trnsmitted by means of concave mirrors, lens type antenna, or horn shaped antenna. To act as a directional antenna the mirror must be shaped just right so that the waves sent along form various points of the mirror have their crests together and add up. The horn antennas are used like megaphones. The signal comes in the small end and leaves almost uniformly out the large end of the horn. If the large end of the horn is many wavelengths in diameter, the beam sent out can be very narrow.

Ordinary types of electrical transmission lines cannot be used to run microwaves into the equipment. Lines act effectively as antennas and radiate the electromagnetic power into space, instead of conducting it into work. Wave guides must be used for conducting the microwave electromagnetic power. These consist of actual copper pipes, highly refined, with silver plated interiors and, in some instances, are special glass filled affairs. These hollow pipes act as conductors of the micro waves or project them from an open end.

The microwave system was highly developed during World War II for the transmission of messages from point to point. It can be used in relaying, telemetering, supervisory control, and communication. A large number of quantities can be transmitted on a single beam, thus cutting down the number of channels of communication needed.

Since the microwaves are short wave

Here is an example of a microwave tower with the facilities for relaying located at the bottom of the tower. There are two receiving ond transmitting antennos.

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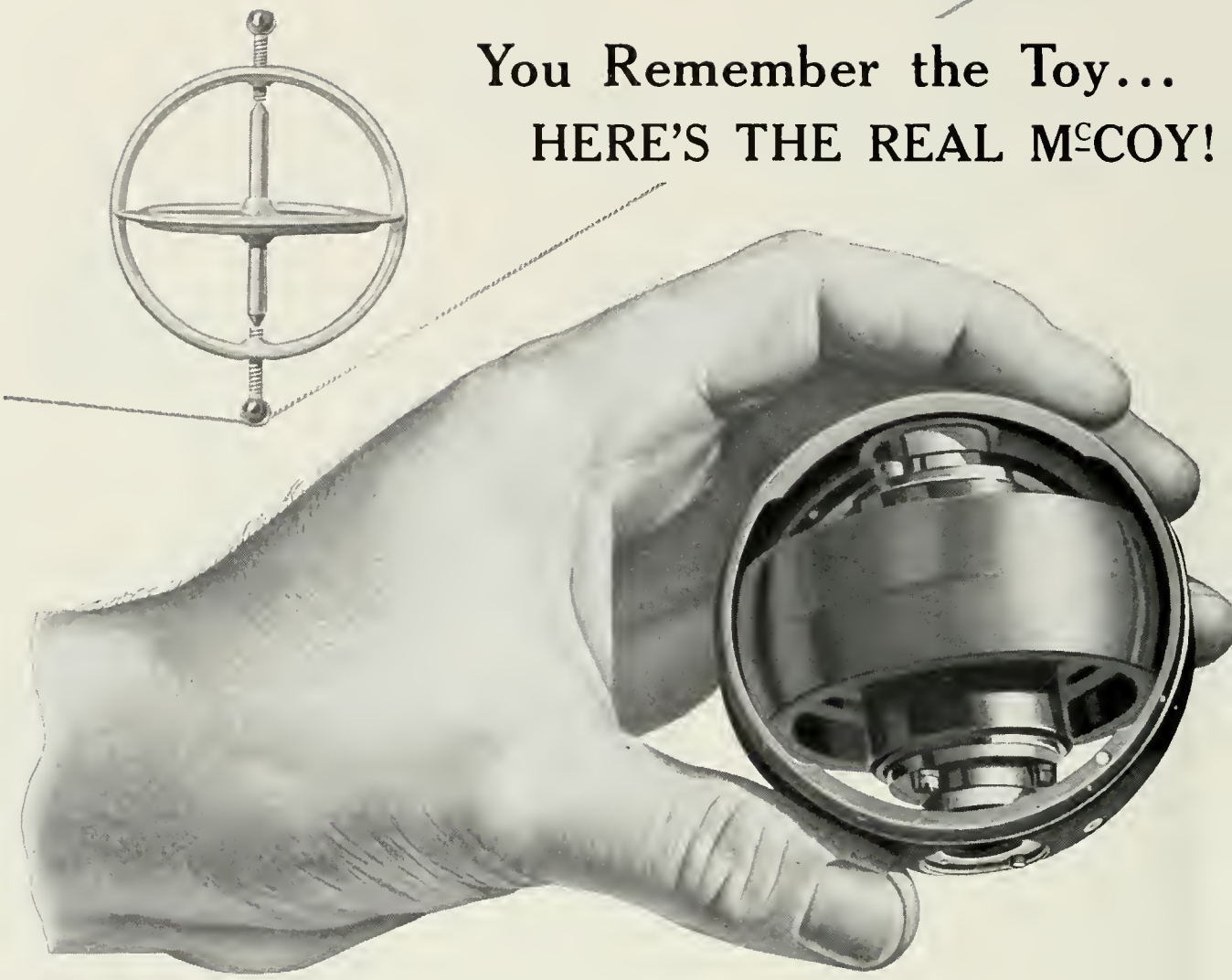

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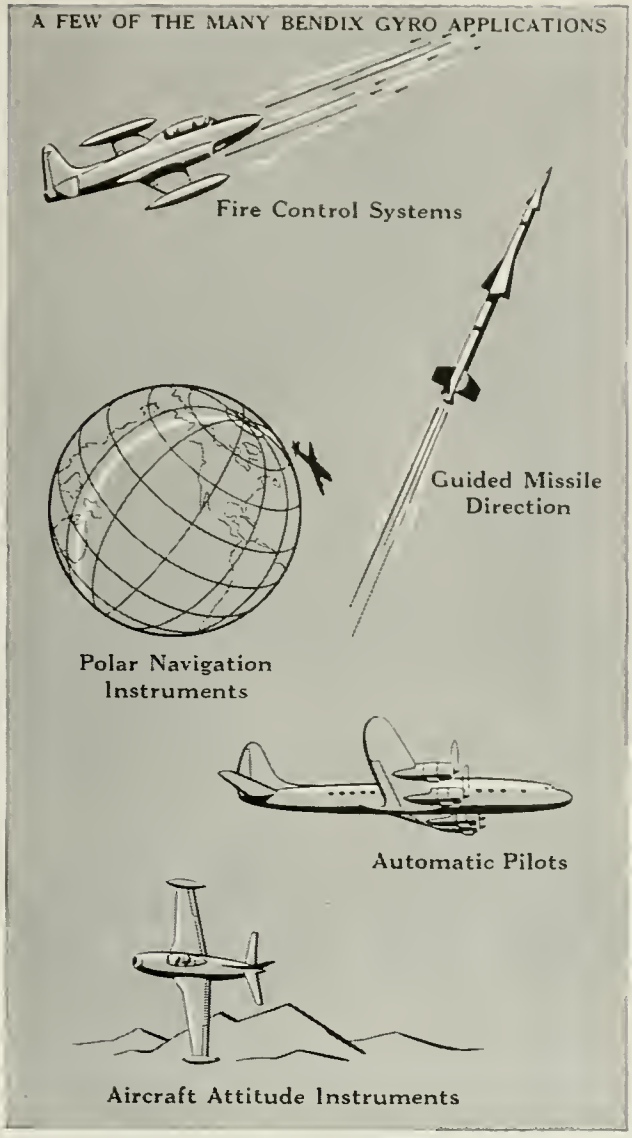

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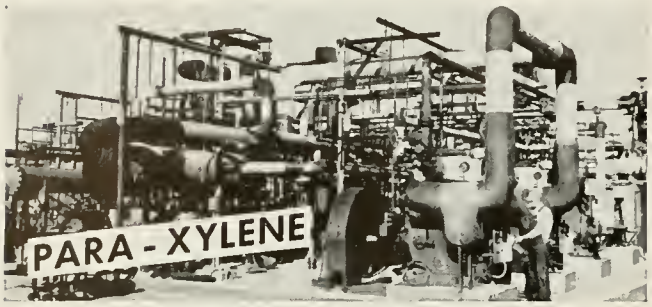
Below Right: Three of the six Frick refrigerating machines in service at Big Spring, Texas.



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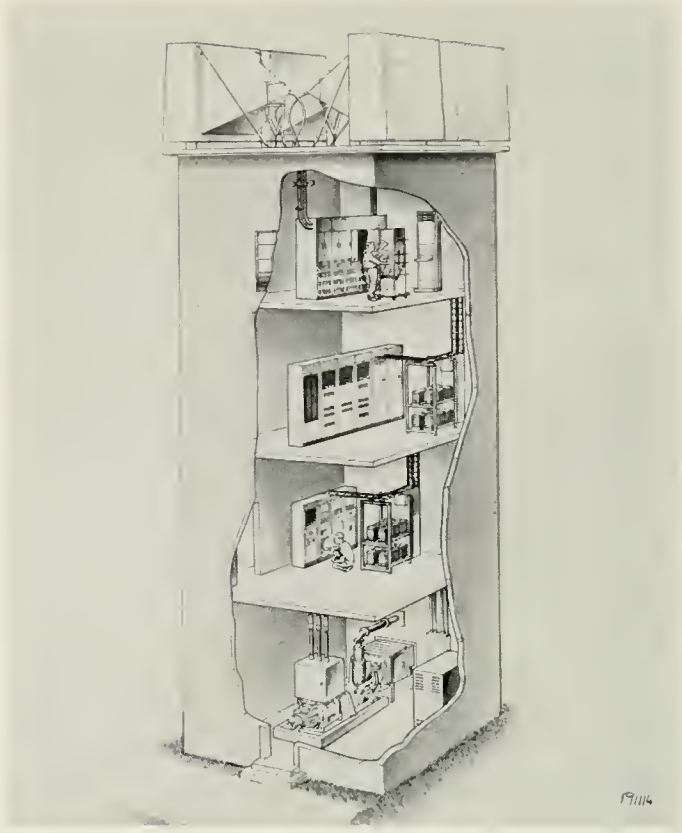

This reloy tower, with the reloying facilities located in the tower proper, is similar to the ones used in the TD-2, the relay system employed by the Bell System. The power facilities are located at the battom and the bays of receiving and transmitting equipment ore located on the upper floors.

lengths and travel like light, interfering objects block the line of transmission. Because of this, much depends on the line of sight between towers for transmission. Since the earth curves, the distance between transmitting towers must not be too great. Between two 200 foot towers it is possible to transmit 35 miles. Two 100 foot towers are good for 20 miles and one 200 foot and one 50 foot tower are also good for 20 miles. For this reason the towers are usually placed on as high ground as possible.

The number of microwave channels able to be used depends on three factors:

1. The line of sight characteristic
2. Angular direction characteristic
3. Frequency selection.

Fifty miles away from a given installation the line of sight on a straight line for the tower would be 1650 feet above the earth and the same frequency the other tower had could be used over again. The entire spectrum available to the microwaves could be used in each 100 mile square area. Many channels could be used at the same frequency because of the directness of the pattern; i. e., fairly high degree directional antennae are used. Using a conservative figure of twenty degrees, four signals could be sent in four directions from a given point without interfering with each other, discounting reflection from buildings, etc.

There are a great many advantages which can be listed for microwaves. A microwave is as reliable as the atmosphere through which transmission takes place. It is not dependent on pilot wires or the continuity of transmission line conductors. Microwave channels would not be subject to the same degree as transmission lines to conditions such as sleet, windstorm, airplane damages, etc.

The intelligence required by a large number of different functions can be transmitted on a single microwave channel using modulated subcarriers. The maximum number of channels which can be provided is dependent on the type of multiplexing equipment used.

Interference in the microwave band is very small and may even be a negligible factor. This works in the sense that microwaves won't interfere with other facilities and other facilities won't interfere with the microwaves. An exception to this would be obstacles in the path of the waves such as an airplane coming directly between two towers. Rain and snow do not affect the lower frequencies. Above 10,000 megacycles they may suffer absorption and refraction by the atmosphere.

Since the microwave channels and terminal equipment are independent of the power system, maintenance can be performed without the necessity of having any part of the power system out of service. This simplifies and makes safer the repairing where maintenance of a coupling capacitor of the line trap is necessary.

A well designed microwave system provides an extremely flat frequency response even though the signal must pass through many relay stations in tandem. This gives a superior voice quality.

Power line carrier systems must often use the same frequency in both directions to conserve spectrum. This requires use of a push to talk switch. Standard microwove systems permit simultaneous two way transmission.

In contrast to the crowded carrier spectrum, the microwave spectrum is tremendously wide.

Everything doesn't work to an advantage in the microwave system for it also has several disadvantages. With the high voltages necessary it means that an a-c power supply will be needed with the present equipment For some uses this is no disadvantage but in relaying, where reliability is important it will be necessary to use a continuous d-c to a-c power supply unit in order to use station battery power. In other cases it

12 of the basic industries in which Bendix products play a vital role

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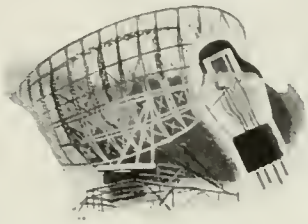
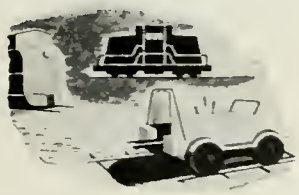


RADAR

COMPUTERS

MARINE



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This is also one of the types used by the Bell System, showing the view from the outside. The size of the tower can be compared with the cars and telephone poles located along side of the tower.

will be necessary to have transfer equipment to go on battery in case of an a-c power loss.

Since the beam is so directional, rigidity of the structure is important and the cost may be high for one of that type. However, with a fairly broad beam deflection is not too important.

When there is trouble in a part of carrier only one channel of communication is usually affected but in the case of microwaves, if part of the multiplexing or radio frequency equipment goes bad, many channels may be knocked out. This can be eliminated as longer life tubes are developed and by the use of duplicate set-ups.

Perhaps the most well known application of microwaves is that of relaying. In locations where a large number of circuits exist between two points a microwave channel may be used to convey the intelligence. Under this category would fall those stations which use power cable, where the use of carrier equipment would not be possible.

A microwave channel provides an ideal means of transmitting a large number of quantities desired.

The company which probably has gotten the most out of microwave relay systems is the Bell System, through its parent organization, American Telephone and Telegraph. At the end of 1952, Bell System had completed 6000 miles of their system, which is called the TD-2. The TD-2 is the most extensively used in the world. Both telephone and television signals are transmitted.

A. T. & T. constructed its first multiplex microwave relay system between New York and Boston. This system was known as the TD-X and it was placed in service in 1947. It has been used ever since for the regular transmission of television. It operates on the frequencies between 3900 and 4200 megacycles. Two channels are beamed in each direction. The TD-X was also used for a telephone transmission trial during which a pair of radio channels satisfactorily carried 240 simultaneous telephone conversations.

Microwaves in the TD-2 are beamed by lens type antenna. The average distance between stations is about 30 miles. By making use of hilltops, greatest height possible is obtained for the towers. The TD-2 can provide six wide band radio channels in each direction over a given route. To obtain this, the 500 megacycle band was divided into twelve channels with forty megacycles separation between centers. Each band is twenty megacycles wide with a twenty megacycle guard band. (On a spur route almost parallel to the main route, the guard bands are used as the channel frequency reducing possible interference between the two routes.)

The frequencies used for transmitting and receiving are alternated station by station. Thus, station "A" would be receiving at 3730 and would transmit the same intelligence at 3770. Station "B", receiving at 3770, would transmit at 3730. This way, possible interference between receiving and transmitting signal is eliminated.

In the TD-2, each relay station constructed has facilities for handling six radio channels. At the relay stations, each channel requires its own bay of radio receiving and transmitting equipment. Combined energy of the six channels is picked off by the antenna and it is transmitted through waveguide filters at the top of repeater bays, each of which picks off its own channel frequency and passes the other with negligible loss. Similar filters combine the transmitted energy.

Each of the individual radio channels is capable of providing a television channel with a band width greater than eight megacycles. These channels can be used for transmission of one television program or 600 telephone circuits using the same multiplexing systems that are used in the coaxial cables. Since one of the six available channels is kept in reserve, using five channels, the TD-2 system can provide ten television circuits (five each way), 3000 two way telephone circuits, or any combination of the two.

Another application of microwaves, entirely different from communications, is that of heating. Industry uses the microwaves in dielectric heating for drying dyed cloth, printed cloth, and paper, for curing, or for setting resins or glues. Using flexible wave guides, a flexible hose with a divergent taper at the end of it could be used to spread microwave energy over a large area making possible a microwave stove. The Radarange, made by Raytheon, utilizes this type of construction. The commercial model was engineered and designed primarily for extremely rapid cooking for drive-ins and other similar places. It cooks a hot dog in fifteen seconds and raw hamburger and onions in 35 seconds. The input power for this stove is 4½ kw at 115 volts, 60 cycle, 40 to 45 amps, or 230 volts, 60 cycle, 20 to 22½ amps.

It seems that the future for microwaves is unlimited. Already they play an important role in our daily life.

A Campus-to-Career Case History

"This is what I did yesterday"

"I like a job that keeps me jumping," says Bill Jermain, C.E. from Marquette, '52. "And my first management assignment with Wisconsin Telephone Company does just that. I'm Service Foreman at Sheboygan, with nine installers, and that means variety of responsibility. But judge for yourself. Here's a quick run-down of what I did yesterday, on a typical day—

8:10—"Checked day's work schedule. One of my new men was putting in a buried service wire, and I went over the job specs with him to be sure he had things straight.

8:30—"Answered mail while my clerk checked time sheets from previous day.

9:30—"Out to supervise installation of the first aluminum Outdoor Telephone Booth in my exchange. Reviewed the assembly instructions with the installers, then arranged for special tools and bolts to be delivered to the job.

11:30—"Drove across town. Made a 'quality inspection' on a telephone installed last week. Everything checked O.K.

12:00—"Lunch.

1:00—"Picked up film for next day's safety meeting. Watched the film, made notes for discussion.

2:00—"Met with moving company manager to estimate cost of telephone cable lifting for a house moving job. Drove the route he had planned and worked out schedule for construction crews.

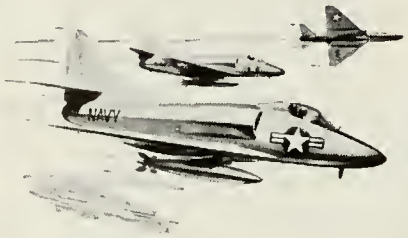
3:30—"Returned to aluminum booth installation. Went over wiring specs with the electrician.

4:00—"Stopped at Central Office to pick up next day's orders. Met installers at garage as they checked in and assigned next day's work."

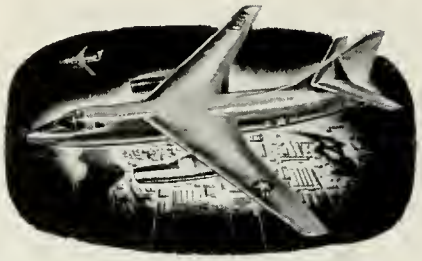
Bill has been in his present job about a year, and is looking forward to new responsibilities as his experience increases . . . as are the many young college men who have chosen telephone careers. If you'd be interested in a similar opportunity with a Bell Telephone Company . . . or with Bell Telephone Laboratories, Western Electric or Sandia Corporation . . . see your Placement Officer for full details.

BELL TELEPHONE SYSTEM

F4D, "SKYRAY"— only carrier plane to hold official world's speed record



A4D, "SKYHAWK"— smallest, lightest atom-bomb carrier



RB-66 — speedy, versatile jet bomber

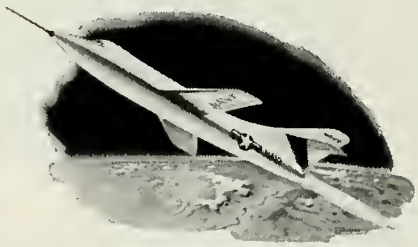
A3D, "SKYWARRIOR"— largest carrier-based bomber

C-124, "GLOBEMASTER"— world's largest production transport

DC-7 "SEVEN SEAS"— America's finest, fastest airliner

Engineers: join this winning team!

"NIKE"— supersonic missile selected to protect our cities



D558-2, "SKYROCKET"— first airplane to fly twice the speed of sound

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The Chemical Engineer in a Consulting Organization

What are the opportunities for a chemical engineer in a consulting group? What are his chances for advancement? How does the job compare with one in a specific industry?

I will try to answer these questions in a general way and can perhaps give you a picture of what some of the factors are which might help you to enjoy your job, and some of the principles which might help you to succeed in it.

One way in which consulting work may differ from that in a specific industry is that the former involves great variety. Consulting engineers may have to design and install a plant for making peanut oil or tung oil alternatively —as we did on the Island of Madagascar—or may have to design a plant for the separation and purification of magnesium—a job we also have done. Actually, the work itself is not essentially different whether done in a consulting group or in the laboratory or drafting department of a chemical manufacturing firm. The set-up is much the same; the demands on the technical ability and need for personality adjustment and cooperation are similar.

Some consulting groups are relatively large, some small. Advancement in either case depends largely on the individual, his interest in his work, the drive he puts into it, and his willingness to accept and meet responsibility. One way of demonstrating this spirit is by consistently doing a little more than is actually demanded.

Whether to take a job that has been offered should be decided chiefly by whether you think you will *like* the work. If you really like your work, it will prove a challenge and hold your interest. Then you will want to keep it, and advance in the company as your experience warrants it.

The Salary Question

Salary should, of course, be "the going" rate for your training and experience. It is not necessarily the dominant factor in a job offer. If salary is your first criterion, you should probably try to get into sales rather than into technical work.

A survey of the incomes of American Chemical Society members for 1950—these include both chemical engineers and chemists—showed that people in these professions make fairly good salaries which vary with the particular job classification. Of twenty-one categories, only four showed a higher percentage of people getting $6,001-$10,000 than those getting $3,001-$6,000. These were for people employed in patent work, sales, consulting, and administration.

In all other classes of work, such as research and development, plant operations, plant control, teaching, and government employment, the largest number employed in each was at the $3,001-$6,000 salary level.

Patent work is highly specialized, requiring both technical and legal knowledge, and an interest in careful and accurate phraseology. A high percentage of patent attorneys are in the upper salary brackets. Sales work demands technical knowledge, pleasant personality, drive, and persistence. In consulting work, a good technical background is highly important because the consultant is selling services. He has to get results and get them with a good measure of economy. In other words, he must be a good business man as well as a sound technical person. Administration is always the most highly paid work because it involves determining broad policy and supervising—sometimes closely, sometimes remotely—the work of others. More than half of those reporting as employed in industrial administration got over $10,000 a year.

The Position of Management

No beginner is going to be high in the administration of a company. He needs experience and he has to add a great deal of real learning to the training he received in college. However, those at the top are always looking for good younger workers to grow into position of leadership and so share in the general management picture. As soon as an engineer or chemist has one person under him whose time he is responsible for, he becomes a part of management, even if it is only the person who washes glassware. Every ambitious young person should aim at reaching some degree of supervisory responsibility as soon as possible.

The supervisor at any level has the privilege of giving instructions—often called orders but preferably phrased as suggestions. The responsibility is to see that the instructions or suggestions are clearly enough worded so that they will not be misunderstood and that the person to whom they are given is capable of carrying them out. Don't tell a draftsman to figure the manufacturing costs of a plant when he only knows how to make the drawings for it.

Good management is important in any industry but it seems as though it is especially important in a consulting organization. Management has the doubtful privilege of deciding how, where, and when work is to be done and the responsibility of seeing that the how is feasible, the where physically adequate, and the when attainable. In short, the responsibility for getting results ultimately devolves on management and no "General blamed the Colonel, Colonel blamed the Captain, etc." will serve.

A privilege of management is that the leadership which carries the responsibility of setting a good example in every way, and in particular of conferring with such assistants at such intervals as are necessary to provide that leadership. Management has the privilege of determining policy, particularly with respect to personnel relations and then is definitely responsible for seeing that policy is followed and personnel kept happy.

The responsibilities of management outweigh the privileges. Some men take the privileges delegated to them, then try to have someone else take the responsibility, notably by checking every point with the person to whom they report. Such people do not last long.

Let us see how one does research. We all do it in basically the same way. We get together what we think are a number of competent group leaders. We assign them what we believe are adequate personnel. We define the objectives to be attaind, we cooperate on the plans for carrying out assignments, and we give guidance as the work progresses. It is then the duty and responsibility of the group leaders to do or have done the day-to-day job of preparing set-ups —I mean of equipment rather than the liquid variety—conducting the laboratory work, making observations, entering records, writing progress reports, and drawing conclusions. They, the group leaders, *must* cooperate, collaborate, and coordinate.

Management would like to select competent people and then give them their problems and their budgets and sit back and have things roll along. That's idealistic, but unrealistic. Results

have to be evaluated to see whether a particular group is getting anywhere on their problem or problems. Guidance has to be given. It has to be given in such a way that the guidee feels that it's only guidance, not instructions. Nothing kills initiative quicker than instructions of exactly what to do and how to do it. Technical people have to be listened to sympathetically and encouraged when the going is rough. Overenthusiasm when things go well must also be minimized so that the swings from enthusiasm to discouragement will be lessened.

Any research organization, consulting or otherwise, is neither better nor worse than the sum of the knowledge, experience, and capabilities of its total personnel.

As a matter of management the research group is the basic unit. Possibly in consulting, we give more authority to the group-leader level than does the average executive in industry. I use group leader as a descriptive term; there are varied titles used within different industrial organizations for the person at that level of responsibility. Actually this is a person who has from one to ten people working under him. The workers are assigned laboratory space and do the actual operations. The degree of supervision naturally coorelates with the particular work assignment and with the degree of experience of the worker.

Periodically I tell our group leaders: "You must so handle your assignments that you get the maximum of productive effort, the optimum of results." Theoretically the exact hours kept are not of first importance; practically it's bad policy to make exceptions as it creates hard feeling among those who may feel less privileged. The ideal research man is his own boss. He finds it harder to please himself in terms of results than to please management. He wants to get the facts, and to know what his results show; in other words, he becomes interested in the problems for their own sake. Therein lies the answer to creating scientists, whether they work at a lab bench, in a pilot plant, or do desk work.

Not all men advance at the same rate. The most valuable men are not necessarily those who advance most rapidly. Steady progress is better than the brilliant advance which can't keep up. To look at it from a different angle, the "genius" is often a problem child. A few years as a member of a group is followed by a year or two as a strawboss to break in on managing at the group leader level.

A man should segregate his personal likes from his research to a reasonable extent. That doesn't mean that he should not ever discuss his work at home or his home at work. It does mean that his wife's, children's or girl friend's tantrums or illnesses or perversities should intertere with his work no more than a reasonable amount. Over the years I have had a secretary fall in love and another one get religion. In those particular cases the results were fatal to production.

There's on type of engineer we can do without—the flash-in-the-pan type. He accomplishes one result of greater or lesser significance. His company adopts it—it a product, usually a minor one—then the inventor expects to repose quietly on his derriere for the rest of his useless life. The chemical engineer we want finishes up one accomplishment and goes on to the next.

We have to live with our fellow man. Engineers too must be capable of doing so. Therefore, the workers all of us are looking for are pleasant and tolerant of their fellow man. When I say that a worker must be tolerant, I mean tolerant of others' opinions, not of the legal triumvirate race, creed, or color, although that kind of tolerance is desirable. More specifically, a man may have an opinion as to a product, process or reaction. But if he tries to defend that opinion instead of being open to adverse opinion, subject to experimental proof, he may find himself defending an obsolete position while others go on. Perhaps it is best expressed that he must have a belief in and respect for the intelligent and intelligence of others as well as his own.

In technical thinking, a good worker must be logical. He is preferably but not necessarily logical in other thinking. This leads inevitably to his not being willing to accept anything fully until he can examine it by logical processes of reasoning and prove it experimentally.

Imagination is necessary. A worker must recognize a desirable result when he sees it, even if it is not what he started out to get. I do not mean that an unsuccessful pancake flour can be expected to be a good adhesive. But an attempt to produce milled toilet soap in a rubber mill gave the U. S. our most widely used process for making floating soap, while milled soap is still made the same old way with minor variations.

A man must continue to learn throughout his professional career. Just recall that a man who stopped learning in 1940 would today know really nothing about antibiotics, atomic fission, or benzene from petroleum. All of you must have a curiosity about what will be new in 1960. We don't know what it will be but we know it *will* be. We want that type of person.

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actory testing of J.S." electrical wires and cables

CABLE TESTING (Part I)

has been indicated in a previous section of this series entitled Cable Specifications" that practically every element of insulated ectrical wires and cables may be covered by some specification equirements. Numerous tests are, therefore, necessary to determine ne suitability of such cables for the application for which they are esigned. These tests may be conducted on (a) the cable elements uring manufacture, known as preliminary tests, (b) the completed ables at the factory, final tests, and (c) after installation. Some of ne preliminary and final tests at the cable factory such as conductor esistance, high voltage, insulation resistance and corona level are, enerally, non-destructive tests and may be conducted on each ntire length of cable manufactured. Other tests, such as insulation nd sheath thickness, physical, aging, moisture, resistance, ozone esistance, capacity and power factor, short-time dielectric strength nd cold bending and long-time dielectric strength tests are made on hort samples selected from a lot of cable.

No. 9 in a series

The following is a general description of these tests and their significance as applied to insulated electrical wires and cables. Details of the test equipment required and the specification requirements are not discussed since they are covered by industry publications such as those of the American Society for Testing Materials and the Insulated Power Cable Engineers Association.

FACTORY TESTS

Factory tests are performed for the following purposes: (1) to determine whether the materials of which the cable is made have the required quality; (2) to determine whether the manufacturing processes such as wire drawing, annealing, compound mixing, insulation extrusion and vulcanization have been performed properly; (3) to detect partial or incipient faults that may have accidentally failed to be detected in the tests indicated in (2); and (4) to determine whether the cable meets the customer's specifications.

Tests on Entire Lengths

CONDUCTOR RESISTANCE. Test is made to insure that the conductor has the required average cross-sectional area and, hence, that its resistance does not exceed the allowed maximum.

SPARK TESTING. The entire length of insulated conductor is subjected momentarily to a high potential to detect and permit the repair of imperfections in the insulation that might cause failure on subsequent voltage and insulation resistance tests.

HIGH VOLTAGE TEST. This test is conducted on each entire length of insulated cable to detect potential faults or weak spots in the insulation and to insure that the insulation will withstand the minimum voltage required by the specification for its rated voltage. The magnitude of the test voltage is determined by the type and thickness of the insulation as shown in the following table for 600 volt cables. The time of application is one minute for code grade insulation, and five minutes for the higher grades.

Insulation Thickness and Test Voltage for Rubber Insulations for 600 Volt Service

Conductor Size, Awg or MCM	Insulation Thickness, 64ths Inch	Code Grade	AC Test Voltages Performance and Heat-Resistant	(KV) Ozone-Resistant
14 to 9	3	1.5	3.0	4.5
8	4	1.5	3.5	6.0
7 to 2	4	2.0	3.5	6.0
1 to 4/0	5	2.5	4.0	7.5
225 to 500	6	3.0	5.0	8.5
525 to 1000	7	3.5	6.0	10.0
Over 1000	8	3.5	7.0	11.5

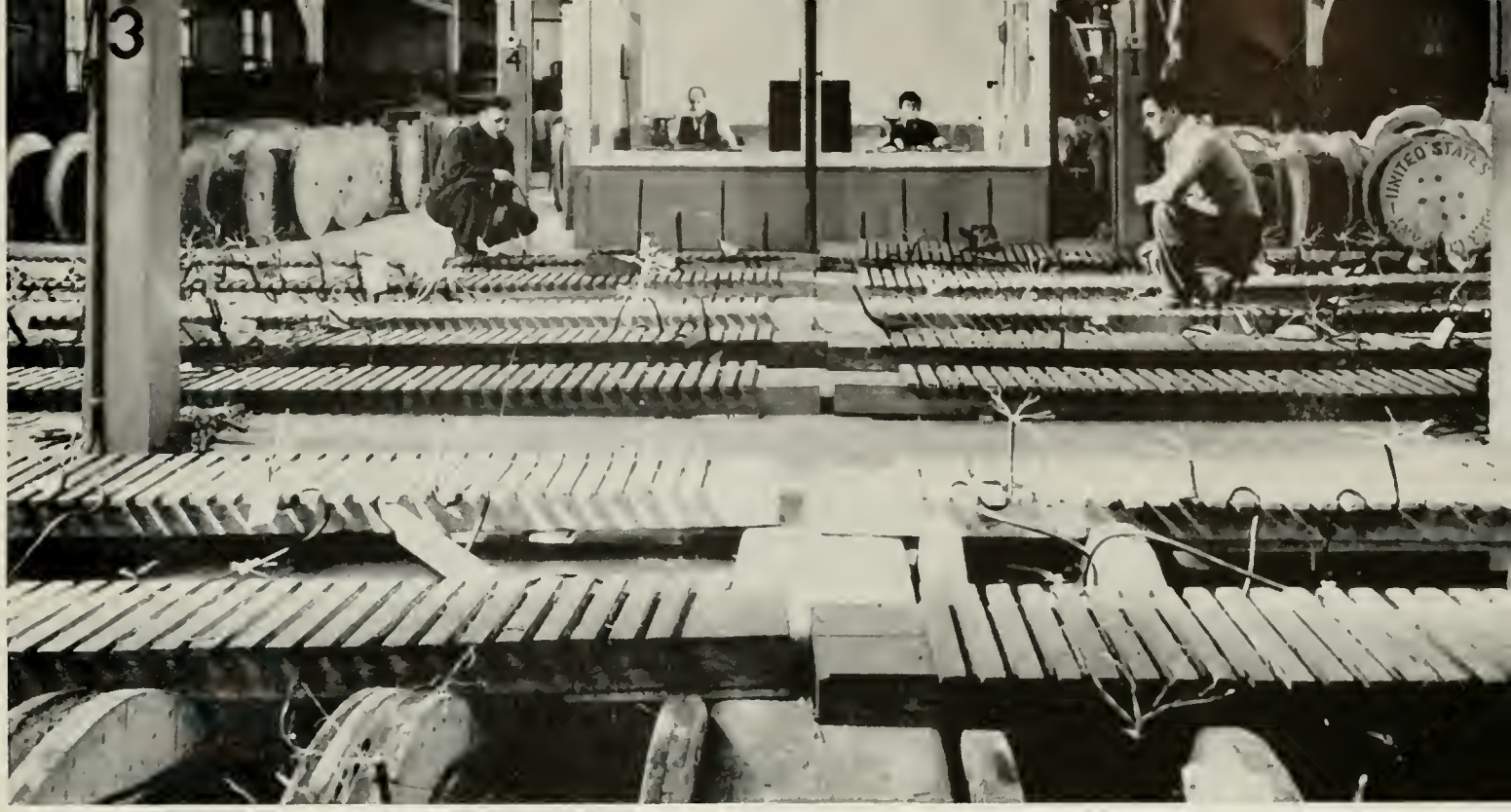
Cables designed for operation at voltages above 5001 are required to withstand a d-c test voltage in addition to the a-c voltage. This d-c voltage is three times the a-c voltage for ozone-resistant insulations and it is usually applied for 15 minutes.

The high voltage test is made by applying the required voltage between the conductor and water in which the cable has been immersed for at least six hours. When metallic coverings are present, the voltage is applied between the conductor and such coverings. Any failures are repaired and the cable again subjected to the voltage.

US RUBBER

UNITED STATES

ELECTRICAL WIRE & CABLE DEPARTMENT



INSULATION RESISTANCE. The insulation resistance test consists of applying a direct voltage of from 125 to 500 volts, usually from a battery, between the conductor and water in which the cable is immersed, or other ground, and measuring the current that flows through the insulation after an electrification of one minute. A suitable galvanometer is generally used for this measurement. From this current and the applied voltage, the resistance of the insulation is calculated and expressed, usually, as megohms (1 million ohms). This test is conducted after the voltage tests and, hence, serves to indicate whether the insulation failed on that test. Insulation resistance also serves to indicate uniformity in processing, particularly insulation compounding, since a well-processed compound should give reasonably uniform insulation resistance. Most wire and cable specifications contain minimum requirements for insulation resistance so that this test determines whether or not the specification is complied with.

The resistance of insulations is inversely proportional to the temperature, that is, it is lower at high temperatures. It is, therefore, necessary to note the temperature at which the insulation resistance is measured and to apply a correction factor to reduce the resistance to a standard temperature. The insulation resistance varies with the type of insulation, its thickness and the size and length of the conductor. The following formula gives the relation between these factors.

$$\text{Insulation Resistance, Megohms} - 1000 \text{ feet} = K \log_{10} \frac{D}{d}$$

Where, D = Diameter over the insulation, inches
d = Diameter over the conductor, inches
K = A Constant for the insulation used

CORONA OR IONIZATION LEVEL. This test determines the voltage at which ionization or corona develops in a length of cable and is usually made only on cable for operation above 4000 volts. It is made by applying a gradually increasing a-c voltage between the insulated conductor and water or other ground with an oscilloscope in the circuit. Any air entrapped at the surfaces of the insulation or within the insulation will ionize when a sufficiently high voltage is applied resulting in the formation of more active oxygen or ozone. These materials are detrimental to most organic insulations particularly when such insulations are under physical tension, and thus may cause premature failure of the insulation. This ionization is indicated by the appearance of high-frequency oscillations on the charging current trace of the oscilloscope. In actual practice, the voltage at which ionization is extinguished rather than initiated is determined. For long cable life, this extinction voltage should be at least 110 per cent of the rated voltage to ground.

Wire and cable specifications generally require that these tests be made on the completed product. High voltage and insulation resistance tests are usually also made immediately after the insulation has been applied and vulcanized. This is general insurance that cables passing the test will meet the requirements when completed.

What's Radar?

by Jack Siebert, E. E. '57

Radar, a word coined by Captain S. M. Tucker of the U. S. Navy, is a discovery about which the general public knows little, but takes for granted. Almost everyone has seen moving pictures of a radar antenna, or perhaps actually seen one in operation, but relatively few have any idea of what takes place at the other end of the apparatus.

If one stands in the vicinity of a cliff and makes a noise of some sort, he will probably hear an echo of the noise. This echo is produced when the sound wave which he created bounces off the cliff and returns to his ears. The farther away the cliff is, the longer it will take the echo to return. Similarly, when one shines a flashlight on a wall, he readily sees a bright spot on the wall. The light waves have been reflected by the wall, and have been received by his eyes. Radar operates on this same principle, the difference lying in the fact that radio waves are used in place of sound or light waves. The word "radar" stands for radio detection and ranging. Designing the equipment to throw out these waves and to then receive them, required a terrific amount of research and technical know-how. The ratio of the tremendous amount of power generated to the minute quantity reflected can be emphasized in the following analogy:

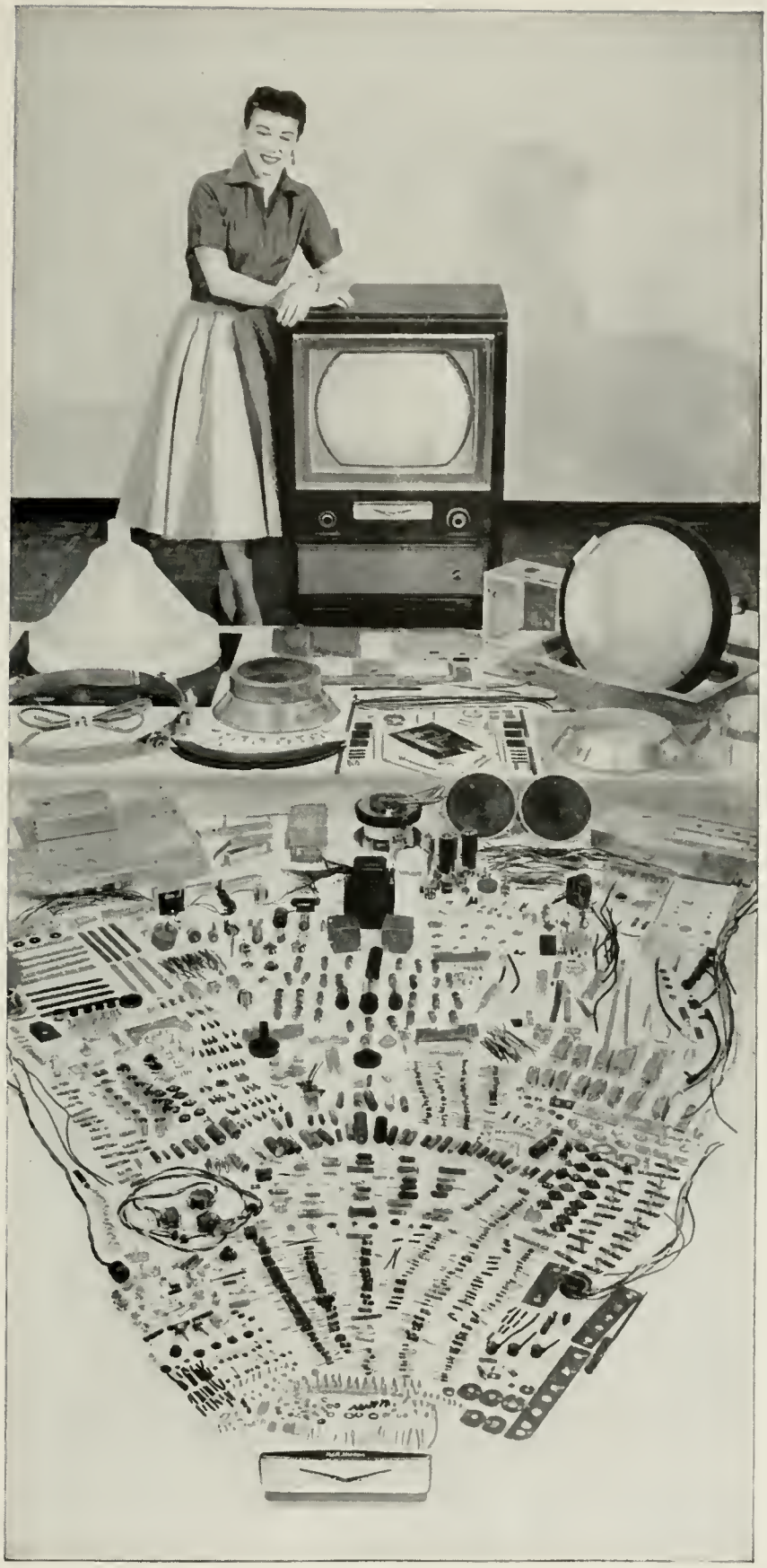
"If it were possible to scoop up all the sand on a typical seashore, throw it at a plane somewhere out of sight behind the clouds a hundred miles away, and have one grain bounce back to tell exactly where the plane was located, we should have a picture of the relative energies involved."[1]

This ratio makes it necessary to use an extremely powerful transmitter and a very sensitive receiver. The radio waves used in radar are in the microwave group. When the frequency of a a radio wave is increased, the wave length is decreased, and when the length reaches that of one meter or less it falls into the microwave category. When the radio waves become this short they are approaching the frequency of infrared heat and visible light. Consequently, they adopt many of the characteristics of these waves, one of which is to be able to be focused into beams much like searchlight. Such a beam of radio waves, which travel at 186,285 miles per second, can be aimed at an object, and information pertaining to the object can be gathered from the returning echo. The radar transmitter, however, does does not send forth a continuous beam of waves. It instead alternates with the receiver. A pulse is sent out, the transmitter shut off and the receiver turned on. When the echo has had sufficient time to return and be recognized by the receiver, it is turned off and the transmitter sends out another pulse. These pulses may be spaced at intervals of a microsecond, and the turning off and on is, of course, done electronically.

The transmitting division of a radar installation is made up of the following components: 1, a modulator, 2, a radio frequency oscillator, 3, an antenna. The modulator is the device which takes the power from the initial source, and after forming it into suitable voltages supplies it to the radio frequency oscillator which generates the microwaves. It is the modulator which turns the radio frequency oscillator on and off for its microsecond pulses. The radio frequency oscillator is a vacuum tube, or a system of tubes which is designed to deliver the desired burst of power at a determined frequency. In radar, hundreds of kilowatts of power may be needed to push the waves out into space. The procurement of a tube capable of producing the needed oscillations at such great power presented a difficult problem, but was accomplished by the development of a special tube called the cavity magnetron. After the high frequency oscillations have been produced it is up to the antenna to direct them out into space. Antenna design presents one of the major problems in radar The antenna must be highly efficient, easily directed in the desired directions, and produce the width of beam which is specified. Various types of beams may be incorporated. When a wide beam is used more complete coverage of the surrounding terrain can be accomplished than with a narrow one; the difficulty lies, however, in that the location of an object can not be precisely located. By using a narrow beam the field of detection is made much smaller, and accurate details concerning the position of the object can be recorded. Antennae can be made to revolve in a complete circle if necessary, or they can be adjusted to scan only a particular horizon. They can also be made to follow a pattern which includes vertical movements. Some radar antennae are parabolic in shape, as are reflectors for light rays.

When the pulses have been transmitted and have been reflected from an object, they are ready to be received and analyzed. The radar receiver may be thought of as two separate units, the detector and the indicator. The task of the detector is to receive the minute pulses of energy which are reflected to it, and to amplify and prepare them for the indicator. The receiver usually uses the same antenna as does the transmitter, and as already stated, operates during the period when the transmitter is shut off.

The radar indicator is the brains of the radar installation. It is the indicator which receives the information gathered by the detector and presents it in such a manner that the operator can put it to use. The method used is to show the effect of the returning echoes on the face of an oscilliscope. An oscilloscope is a closed, funnel-shaped glass tube. In the small end of this tube is a negatively charged electrode (cathode) which directs a constant stream of electrons towards the larger surface of the opposite end. This end of tube is coated with metallic salts that glow when they are struck by a bombarding electron. By directing a magnetic field around the base of the tube, or by placing a positive electron (anode) in the path of the electrons, it is possible to control the path of the electrons and consequently to produce a desired pattern on the face of the scope. By controlling the magnetic field with the incoming pulse from a radar antenna, the information which is received can be presented visually. There are several types of radar screen pictures. The basic and simplest type is called a range indicator, which really is not a picture at all. On the scope, a sweep line, called the time base, extends across the surface horizontally. As each pulse is transmitted a vertical column called a "pip" starts across the length of the line. The distance between these pips can be adjusted to represent any constant distance, and they are therefore serving as range indicators. If an object comes into the path of the radar waves, it will reflect some of them back to the antenna, and after being re-



This picture shows how RCA helps small manufacturers grow

Today the inter-dependence between manufacturer and supplier is stronger than ever in the history of American business. For in the challenging new age of electronics, hundreds upon hundreds of component parts are needed in the manufacture of new products.

For example, the superb new RCA Victor 21-inch color TV set shown here contains 2,070 parts. These are made by 600 different suppliers, most of whom are small businesses.

Indeed, more than three-quarters of all RCA suppliers are small business firms that receive nearly one-half of RCA's purchasing dollars. They, in turn, have their suppliers of raw materials. Thus through a long line of cooperative effort, employment is provided for countless people in many fields—and an entire economy benefits.

RCA salutes its full roster of 7,500 suppliers, located in 43 states, for their inventiveness and resourcefulness that contribute so much to the quality and performance of its products. With these firms at our side, RCA continues to march forward, creating new and better "Electronics for Living"—electronics that make life easier, safer, happier.

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RCA offers careers in research, development, design, and manufacturing for engineers with Bachelor or advanced degrees in E.E., M.E. or Physics. For full information, write to: Mr. Robert Haklisch, Manager, College Relations, Radio Corporation of America, Camden 2, N. J.

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RADIO CORPORATION OF AMERICA

ELECTRONICS FOR LIVING

ceived will appear as a second pip of less height than, and in between the range marks. The distance of this pip from the left end of the time base line will determine how far from the antenna the reflecting object is located. By the use of two scopes, termed A and B, one horizontal and the other vertical, both the range and the altitude of an aircraft can be discovered. The scopes are calibrated in whatever units are convenient for a particular installation. Another widely used type of indicator is the Plan Position Indicator (PPI). This type differs from the range indicator in that the base line swings out from the center of the tube as a radius. This beam of light is synchronized with the antenna and will scan the same arc that the antenna is adjusted to cover. The advantage of this type is that it gives the range as a radius and the relative azmuth in one reading. Also, as in the case of a shoreline, rivers, lakes, or mountainous areas, it will reproduce a visual outline of the object being viewed. This, of course, is not true with relatively small objects such as planes and ships.

A great scientific discovery such as radar would not be so great if it were not so useful. The part which radar played in World War II was definitely a leading role. In fact, radar has been heralded as the greatest scientific development of the war. The Navy, which pioneered the development of radar, put it to great use. For the first time ships were able to "see" through the dark of the night. Besides being an aid in navigation, radar enabled a ship to train her guns on an enemy vessel which she could not actually see. This happened many times as in the following incident:

"Late on the evening of November 4, 1942, among the Solomon Islands in the South Pacific, one of our new warships was out looking for the enemy. Aboard the American vessel, radar, like an invisible searchlight, probed the darkness and discovered the presence of an enemy vessel more than eight miles away. The big ship lifted its gun muzzles towards the stars. They flashed and thundered. The second salvo, despite both darkness and extreme range, landed squarely on the target, which disappeared from the radar screen."[2]

The worth of radar was definitely proved in the war. Captains no longer needed to guess about the location of the enemy.

So accurate is modern radar, that it can trace the flight of a shell, and in the case of an enemy shell, trace it back to its origin. Radar is extremely valuable for the detection of enemy aircraft. It has even been combined with an anti-aircraft gun so that it will automatically detect the plane and both aim and fire the gun. Radar is also of definite value to aircraft. In the last war the Allies were able to successfully bombard Germany at night, and at the same time through heavy fog and clouds by utilizing radar. Radar is also used to aid a plane in making a landing. Two methods, known as Ground Controlled Approach (GCA) and Instrument Landing System (ILS), are commonly used. In GCA the pilot is given directions by a man on the ground, while in ILS the pilot reads instruments in the plane and is responsible for landing the plane.

As helpful as radar is, it also has its faults. Microwaves, unlike longer radio waves, will not travel beyond the curvature of the earth, therefore the range of radar is limited, and an airplane, by hugging the earth, may often escape detection. Also, methods have developed to counteract radar detection. Due to the fact that radar waves will not penetrate water, it is impossible to detect a submerged submarine. Its merits, though, are so numerous that they overshadow its faults, and it can truly be called a miracle of modern science.

[1]Don Caverly in "The Primer of Electronics and Radiant Energy."

[2]From a broadcast of the Joint Board on Scientific Information Policy—May 31, 1943.

INDUSTRIES THAT MAKE AMERICA GREAT

RUBBER . . . BOUNCING HIGHER AND HIGHER

Rubber, natural and synthetic, is so elastic in its applications to daily living that millions of people ride on it, walk on it, sit on it, sleep on it—in fact, use it in more than 80,000 different products. 1,498,906 tons were consumed in 1953 alone. This industry's remarkable growth (U.S. consumption of 2,419,700 tons, or 27.7 pounds per person, is forecast for 1960) is largely due to management's wisdom in reinvesting profits in the tools of production and distribution to encourage company growth.

Anyone whose memory goes back 10 years or more can remember the heroic efforts of the rubber companies by which they averted a serious wartime rubber shortage which threatened both military transport, and family transportation. The phenomenal gains made by the rubber industry in the last decade have met civilian demands and have provided an emergency stockpile as well.

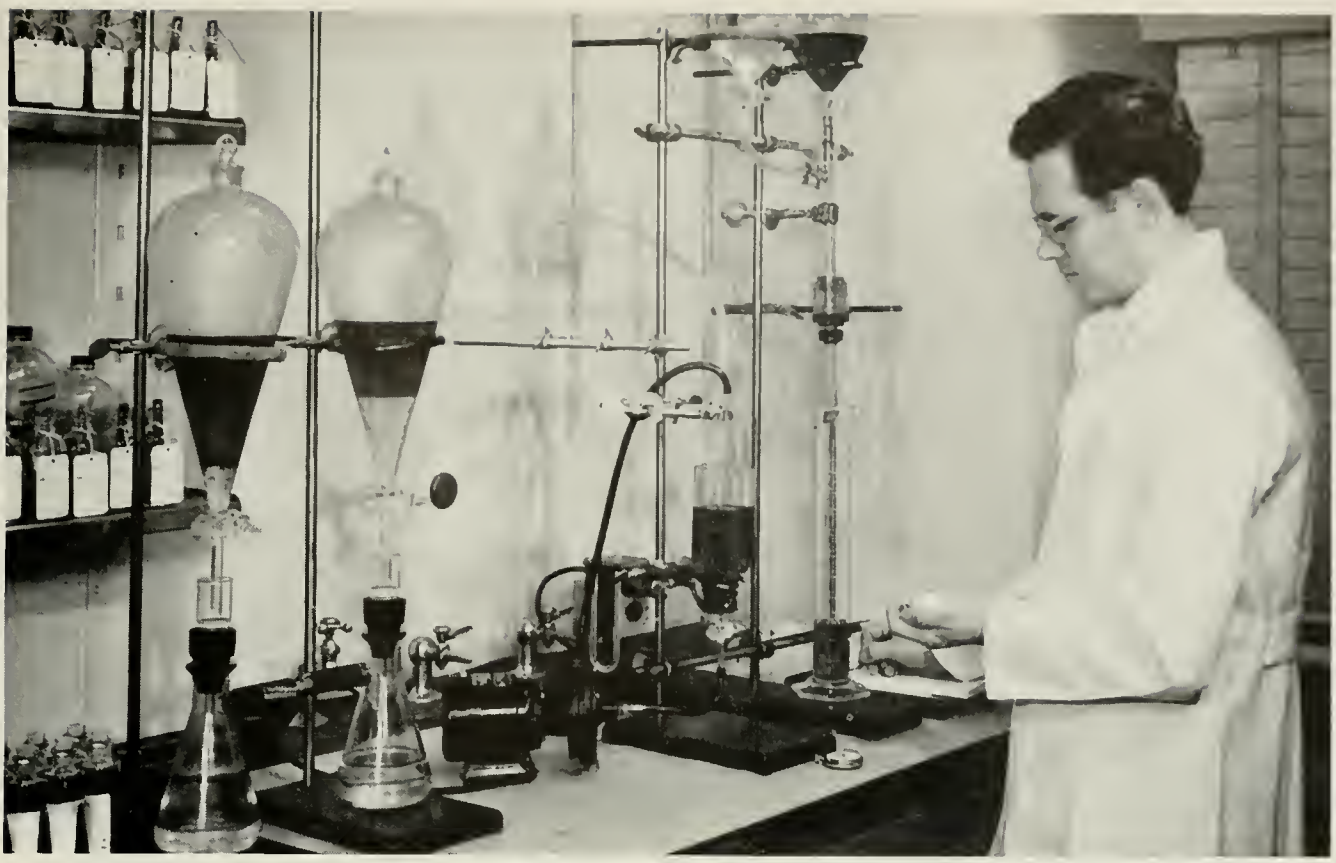
And in this history of rubber research, development and growth, steam has made—and is making—a basic contribution. Without steam and its teammate power, many of the accomplishments of rubber would have been more difficult, impracticable or even impossible to attain.

B&W, through its own vast program of research and development, coupled with boiler building experience dating back almost a century, has made major contributions of its own to the science of steam generation for processing, power and heat—and through them to the modern-day marvels of rubber.

BABCOCK & WILCOX

BOILER DIVISION

N-200



To help develop STA-CLEAN for STANDARD Furnace Oil, the testing apparatus shown here was constructed. Running an experiment on the improved oil is Dr. Jack A. Williams, a chemist at Standard Oil's Whiting laboratories.

HOW TO SOLVE A BURNING PROBLEM!

Scientists in Standard Oil laboratories work with the stimulating knowledge that practical and valuable results will be obtained from their discoveries. A recent achievement of Standard Oil scientists is now benefiting hundreds of thousands of STANDARD Furnace Oil users throughout the Midwest.

In 1952 our research people undertook the problem of finding a method to eliminate oil burner failure or inefficiency arising from clogged filters and burner nozzles.

After months of painstaking laboratory work and many more months of thorough field testing throughout an entire heating season, Standard Oil scientists perfected a new, efficient additive—STA-CLEAN. Blended into our furnace oil, the new additive acts as a detergent, sludge inhibitor and rust stopper—all in one. STA-CLEAN assures clean oil filters and nozzles—a dramatic contribution to efficient and economical heating.

The development of this remarkable new additive is further proof of the progress possible when scientists are given time and equipment to explore and develop thoroughly their ideas. Young scientists find such an atmosphere inspiring.

Standard Oil Company

910 South Michigan Avenue, Chicago 80, Illinois

STANDARD

Moving Sidewalks

—*a reality*

by John F. Aanes
M. E. '56

How many times did you leave the ballpark before the exciting game was over, just to beat the crowd and to get outside the stadium before everything got jammed up? This problem might be solved by a new and revolutionary development—the moving sidewalk.

Such a sidewalk was recently installed at Houston Coliseum in Houston, Texas. The design and installation was a joint engineering project of Link-Belt Company, B. F. Goodrich Company, and Otis Elevator Company.

This "Link-Belt Walk" connects the Coliseum's exposition hall and auditorium with a parking lot which is on the other side of the Buffalo Bayou. It is the first moving sidewalk to be installed on a pedestrian bridge. The walk is 114 feet long, and the belt is 82 inches wide. It travels up a seven-degree (12 per cent) incline with a speed of 32 feet per minute, which is slightly faster than an ordinary escalator.

The whole run takes about 52 seconds, and the belt is capable of transporting 15,000 passengers in an hour. Passengers step on and off as if it were an escalator, and it gives them the option of riding without any effort or of adding their own walking speed for a quick trip.

In other words, the riders can either save time or effort. The run is reversible, so it can handle either in-going or out-going rush.

The Beltwalk is powered by a 25 h.p. motor through a double reduction helical gear and triple-width roller chain drive, which drives the pulley located at the upper end of the walk. The belt wraps tightly around the pulley and moves in the same direction. The belt itself is 230 feet long and seven-eighths inch thick and made of a specially compounded rubber and reinforced with

The twenty-foot pedestrian bridge between the Coliseum and the new parking lot.

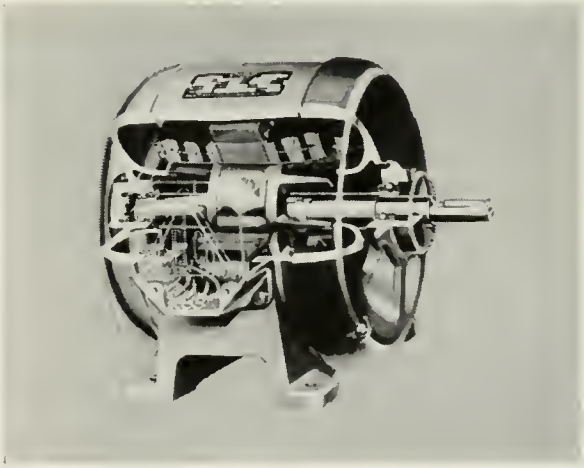
The "Link Belt Walk" at the Souston Coliseum in Houston, Texas—a 114-foot long moving sidewalk that can handle 15,000 people in an hour.

NIKOLA TESLA, THE MAN WHO HARNESSED NIAGARA

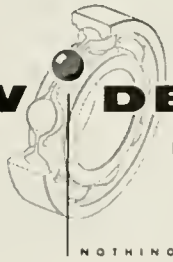
Water, water, everywhere — and no power. That was Niagara Falls when Nikola Tesla began work on its power system in 1888. Now Niagara is one of the world's largest electric power plants.

But to make the most of this power, many problems in electric motor design had to be overcome. New Departure ball bearings have helped solve many of them. For example, motors with New Departure self-sealed ball bearings may be mounted in difficult-to-reach locations because the bearings will operate far years without attention for relubrication or adjustments of any kind.

Highly important also are the facts that these ball bearings resist loads from *all* directions and, being grease-lubricated, permit motors to be applied in any position from horizontal to vertical without loss of efficiency or trouble from lubricant leakage. Whatever the loads, New Departure ball bearings maintain accurate rotor-to-stator relationship — are cool-running at all motor speeds.



New Departure ball bearings assure positive rotor support under all loads in this motor. Bearing seals, pioneered by New Departure, keep lubricant out of the motor. Shields on the reservoir side keep foreign matter out of the bearings.



NEW DEPARTURE
BALL BEARINGS

NOTHING ROLLS LIKE A BALL

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT

ENGINEERING WRITING

Here is an ideal way for the engineer or physicist with some aptitude for writing to enter the field of advanced electronics. In this relatively new and expanding area you can make immediate and effective use of your academic training while acquiring additional experience.

Hughes Research and Development Laboratories are engaged in a continuing program for design and manufacture of integrated radar and fire control systems in military all-weather interceptor aircraft. Engineers who produce the maintenance and operational handbooks for this equipment work directly with engineers and scientists engaged in development of radar fire control systems, electronic computers, and other advanced electronic systems and devices.

Your effort in the field of engineering writing through these publications transmits information to other engineers and technical personnel on operation, maintenance and modification of Hughes equipment in the field.

You will receive additional training in the Laboratories at full pay to become familiar with Hughes equipment. Seminars are conducted by publications specialists to orient new writers. After-hours graduate courses under Company sponsorship are available at nearby universities.

HUGHES
RESEARCH AND DEVELOPMENT LABORATORIES

SCIENTIFIC AND ENGINEERING STAFF

Culver City, Los Angeles County, California

Photograph above: Engineer-writer John Burnett (left) works with engineers John H. Haughawout (right) and Donald King to compile handbook information.

seven plies of fabric. The two ends are vulcanized together to make the walk and endless loop.

The sidewalk is enclosed by three feet high balustrades with moving handrails. The handrails are extended beyond the moving belt at both entry and exit ends, and their speed is synchronized with the speed of the belt.

All parts of the "Link-Belt-Walk" have been designed for maximum safety. The steel idler rolls under the belt are spaced so close that they give a perfectly smooth and effortless ride. The operation is almost noiseless, and all the mechanical parts are enclosed. Still they are accessible for inspection and maintenance, and the belt is easily cleaned.

The sidewalk in Houston Coliseum is the first Link-Belt installation for the public transportation of people. But other companies have made similar installations. A good example is Stephens-Adamson Mfg. Co.'s 227 feet long "Speedwalk" through the Hudson and Manhattan Railroad Company's Erie tube station at Jersey City.

Extensive studies are now being conducted by engineers, architects and traffic experts to determine the future use of moving sidewalks to eliminate the bottlenecks in the pedestrian traffic lanes, convention halls, airports, sport stadia, shopping centers, subways, and so on.

Look for moving sidewalks tomorrow. They are the solution to today's pedestrian traffic problems.

A hot-spell story that we like is about the girl who went swimming in the raw in a secluded millpond. Along came a little boy who began to amuse himself tying knots in her clothes. She floundered around, found an old washtub, held it up in front of herself, and marched toward the little boy, saying: "You little brat, do you know what I'm thinking?"

"Sure," said the little brat, "you think that tub has a bottom in it."

* * *

Some girls are like a zippered nightie, pull anything and it's all off.

* * *

Flossy: "I was out with an inebriated driver last night and he headed right for a telephone pole."

Tessy: "The dog!"

* * *

"What was that explosion on Si's farm?"

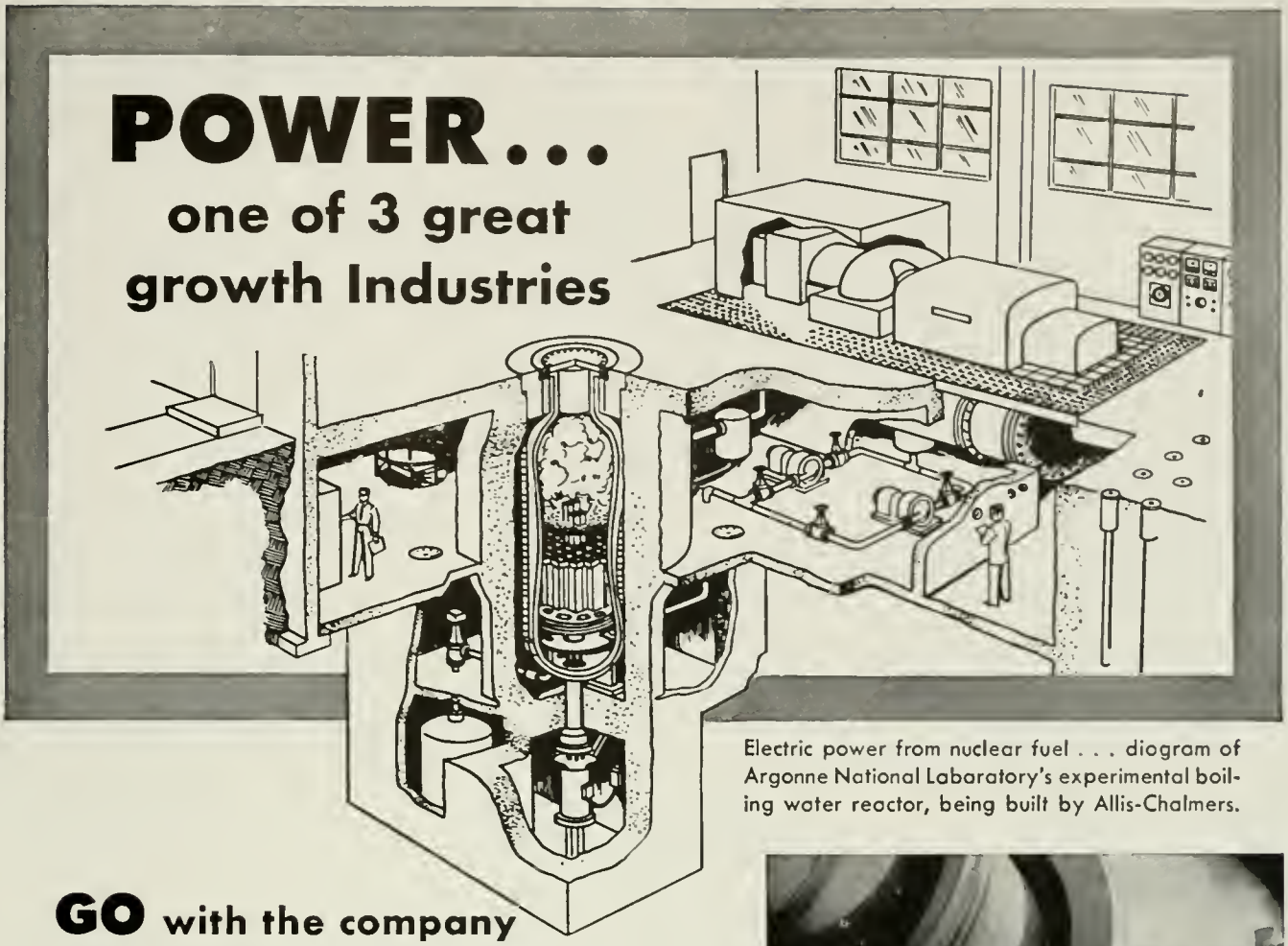
"He fed a chick some 'Lay or Bust' feed, and it turned out to be a rooster."

* * *

Professor—In what battle did General Wolfe, hearing of victory, cry, "I die happy?"

Student—His last battle.

POWER...
one of 3 great growth Industries



Electric power from nuclear fuel . . . diagram of Argonne National Laboratory's experimental boiling water reactor, being built by Allis-Chalmers.

GO with the company that's strong in all three!

Hitch your future in engineering to the growth of the U. S. A.—and to a company that supplies the basic needs of growth!

This nation is growing at the rate of 50,000 people every *week!* To supply the needs of these people:

Electric power generation will double by 1965.

A multi-billion dollar program of new highway construction is planned within the next ten years.

Manufacturing output will have to increase by $3.5 billion by this time next year.

And Allis-Chalmers builds major equipment for all of these growth industries! Some examples are pictured here.

Here's what Allis-Chalmers offers to Young Engineers:

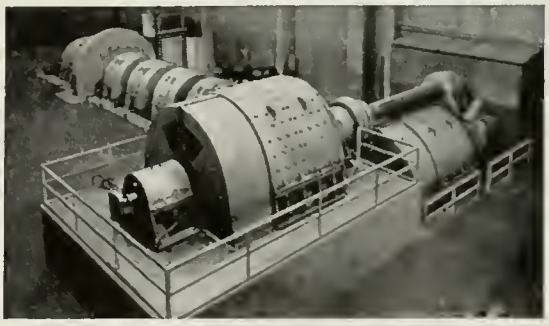
A graduate training course that has been a model for industry since 1904. You have access to many fields of engineering: electric power, hydraulics, atomic energy, ore processing.

There are many *kinds* of work to try: design engineering, application, research, manufacturing, sales. Over 90 training stations are available, with expert guidance when you want it. Your future is as big as your ability can make it.

Or, if you have decided your field of interest and are well qualified, opportunities exist for direct assignments on our engineering staff.

In any case—learn more about Allis-Chalmers. Ask the A-C manager in your territory, or write direct to Allis-Chalmers, Graduate Training Section, Milwaukee 1, Wisconsin.

CONSTRUCTION demands the vast tonnoges of cement produced with Allis-Chalmers rotary kilns and other processing mochinery.



MANUFACTURING depends upon the reliable power of electric motors—like these 5000 hp Allis-Cholmers giants powering a rolling mill.

ALLIS-CHALMERS

A-4683

by Larry Kiefling· M. E. '56

PARKER BADGER

About 2 years ago, in January 1953, a 36 year old man named Parker H. Badger received a diploma from Milwaukee Vocational High School. He is graduating this spring with University

PARKER BADGER

Honors and a degree in mechanical engineering.

Before coming to the U. of I., he had seen a lot of the U. S. and the world. He was born in Boston, and raised in Washington and Philadelphia. He was in the Corps of Engineers during WWII in both the European and Pacific theaters. He had studied air conditioning at Milwaukee School of Engineering for a year and refrigeration in Philadelphia for a semester. He was a machinery salesman for 5 years, and a credit manager for 7 years. He also operated an office supply business.

When asked what made him decide to come to college, he indicated that his lovely wife, Barbara, had no little influence on his decision. At the present time, she is working as a secretary in a LAS dean's office.

Parker is a member of ASME and several honorary fraternities. During his last semester, he was president of ΠΤΣ, mechanical engineering honorary. He also belongs to ΤΒΠ and ΣΤ, engineering honoraries; ΠΜΕ, math honorary; and ΦΚΦ, all university honorary.

JIM PIECHOCKI

Techno-Cutie

Our TECHNO-CUTIE for this month is KAY BOWMAN. Kay is a sophomore in FAA, with a major in art. She has been selected to a host of queen positions including horse show queen, Illio finalist, and dream girl of Pi Kappa Alpha. Kay has been active in Star and Scroll and she has reached the finals this year for cheerleader. In her spare time, Kay enjoys golf, swimming, painting, and horseback riding. Just for the record is nineteen, 5'7", weighs 130 lbs., and she measures 36 - 24½ - 36, either way. Before you run to the nearest telephone, fellows, this blue-eyed blond has been spoken for.

JIM PIECHOCKI

Under the title of one of the main articles in each of this year's Technographs is the credit "by Jim Piechocki, Aeronautical Engineering, 1956." The articles, which deal with such various topics as the sun, the Pogo plane, a WWI ace, Omar Khayyam, an oil refinery, and rocket research, show the wide field of interest of the author.

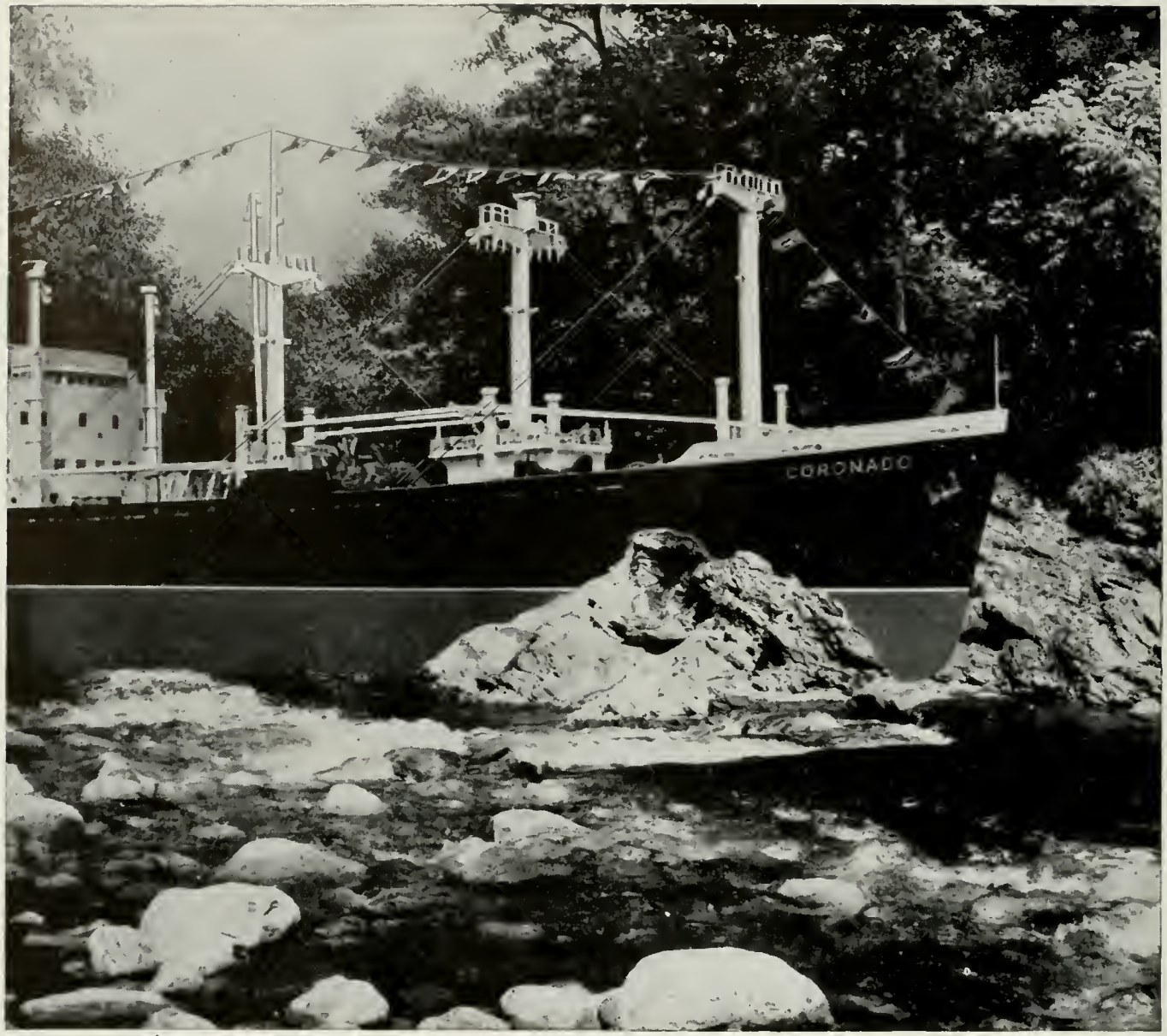
A native of Chicago, Jim transferred to the Urbana campus from Navy Pier. While at the Pier, he engaged in many diversified activities. He was chairman of the Institute of Aeronautical Sciences (Student Branch), chairman of the Engineering Counsel for a semester, and a track manager. He also wrote several Technograph articles while at the Pier.

Since coming to the Urbana campus, he has continued his many activities. He is vice chairman of I. A. S. and has been elected chairman for next year. He was in charge of the exhibits of the Aeronautical Engineering department at the 1955 Engineering Open House. Jim is also the editor of the Newman Club paper, the "Cardinal."

When he can find time away from writing and aerodynamics, Jim likes to play baseball, dance, or listen to classical music.

Old Lady—Are you a little boy or a little girl?

Child—Sure, what the hell else could I be?



You can't launch an ocean liner in a mountain stream

Initiative alone is not the answer to a man's career. A man can't travel far in narrow, limited confines. Neither can he expand in an unprogressive, stagnant organization. A man needs opportunity to put his ideas into action. He needs to be able to move ahead without waiting for vacancies to occur from death or retirement.

Columbia-Southern is one of the fastest growing companies in the fast-growing chemical industry. It is progressive, alert, and on the move.

Opportunities exist with Columbia-Southern in engineering, research and development, sales, plant design, mining, construction, maintenance, production, accounting, transportation and related fields.

Columbia-Southern encourages its employees to grow professionally and the management believes in placing men in positions of greater responsibilitity as soon as they are ready for it.

Columbia-Southern is going places and it needs good men. If you would like to be a part of this organization, write today for further information to Department P at our Pittsburgh address or any of the plants.

COLUMBIA-SOUTHERN CHEMICAL CORPORATION

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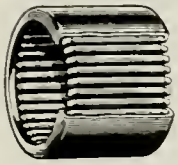
IN CANADA: Standard Chemical Limited and its Commercial Chemicals Division

The Torrington Needle Bearing ...designed for easy, effective lubrication



One major advantage inherent in Needle Bearing design is the ease with which the bearing can be lubricated.

The full complement of small diameter rollers continuously carries a thin film of lubricant to all contact surfaces. The turned-in lips of the outer shell retain the lubricant and effectively seal out foreign matter.

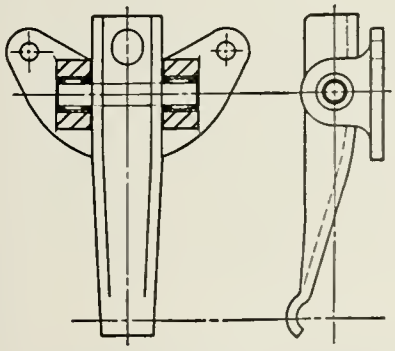
Methods of Lubrication

When Needle Bearings are shipped, they are normally protected with a high-grade slushing compound which has lubricating value at ordinary temperatures. This compound is left in the bearings in most instances. Needle Bearings in many applications run for long periods of time without further attention to original lubrication.

There are several methods of providing additional lubricant to Needle Bearings, as illustrated and described below.

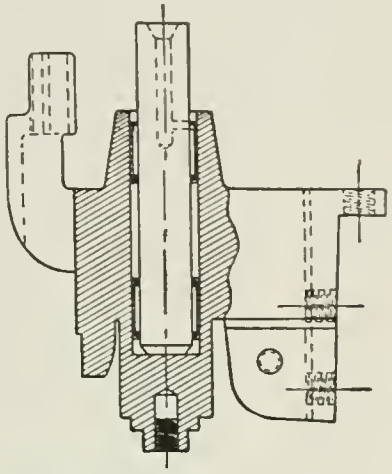
PERMANENT LUBRICATION

For low speed and light load applications, as in the fingers of the automobile clutch illustrated, the Needle Bearings are packed with grease before assembly. No additional lubrication is needed.



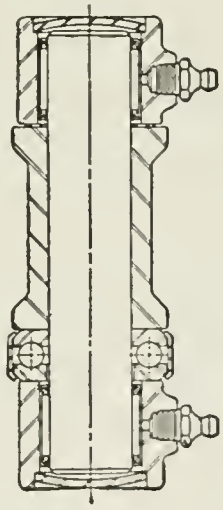
THROUGH THE SHAFT

If it is necessary to lubricate through the shaft, a hole is drilled along the shaft axis, with a cross hole leading under the lips of the Needle Bearing. This hole is located under the lip of the bearing rather than in the roller contact area. Textile machine spindle swing bracket below illustrates this method.



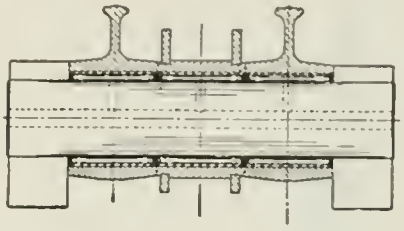
THROUGH THE HOUSING

When lubricant is to be delivered through the housing, an oil hole is furnished in the middle of the outer shell. In automobile king pin below, Needle Bearings are lubricated with Alemite fittings through the oil hole. This oil hole in the outer shell should be outside the load area.



CIRCULATING OIL SYSTEM

For high speeds and heavy loads, a circulating oil system is preferred as it aids in carrying away heat as well as in providing a continuous supply of lubricant to the bearing contact surfaces. A typical example of this method is shown in this Needle Bearing application in the valve rocker arm of a large diesel engine shown below.



Selecting A Lubricant

While oil is the best lubricant, it is difficult in many cases to retain it in the bearing housing. In general, a soda base grease is used in the absence of moisture, and a lime base grease when moisture is present. It is usually advisable to consult a grease manufacturer regarding a particular application.

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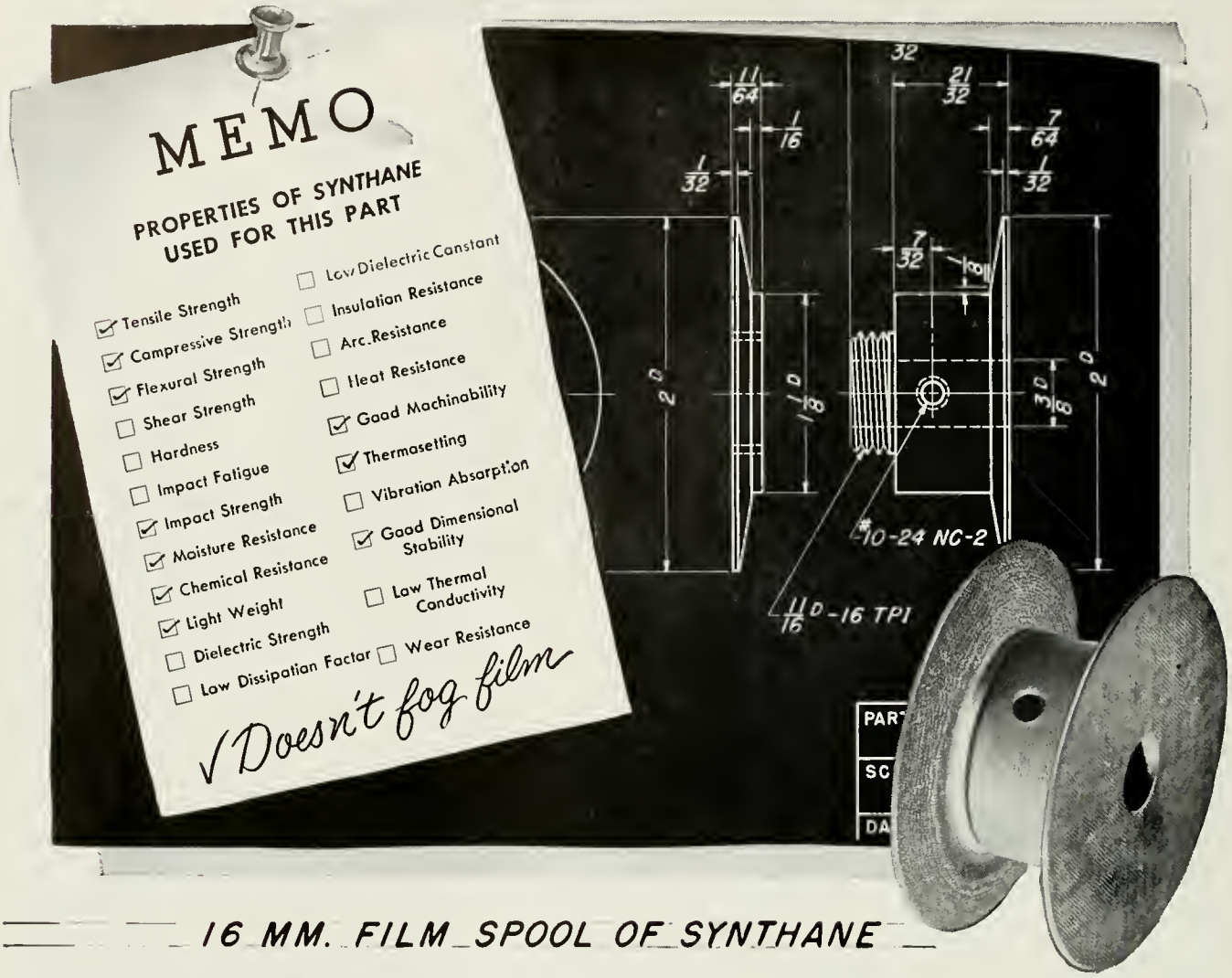

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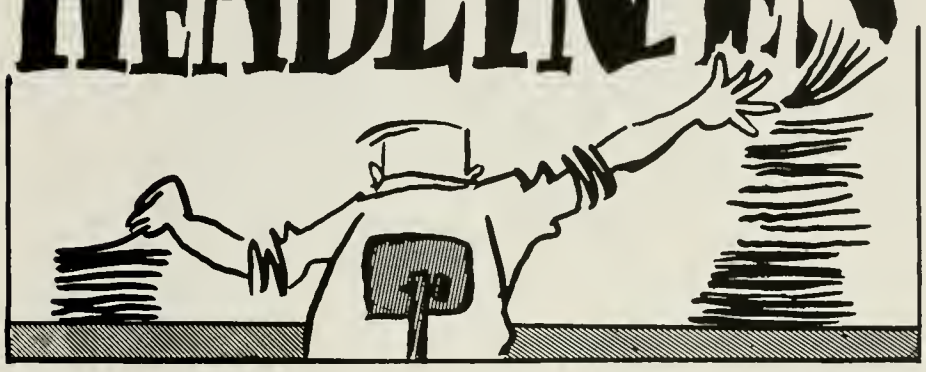

by Larry Kiefling, M. E. '56

Experimental Battery Converts Radiation to Electricity

A tiny semiconductor device that converts either light or atomic radiation directly to usable electrical energy was described here today by scientists.

The device, a silicon junction similar to those used in transistors and in the RCA Atomic Battery, has been employed in experimental solar and atomic batteries at the David Sarnoff Research Center. Using light and radioactive material interchangeably as sources of radiation, these batteries have powered a specially designed low-power transistorized radio receiver.

Discussing continuing RCA research in methods of converting radiation directly to electric power, the scientists pointed out that batteries capable of such conversion promise to find important application in the near future as sources of electrisity for low-power electronic equipment, especially in the field of transistorized devices.

The unit in which radiation is converted to electricity is a wafer of silicon into which an impurity is alloyed to form a junction. When the wafer is exposed to bombardment either by beta particles from a radioactive source or by photons of light, electrons are released within the silicon. These electrons, flowing across the junction, produce a voltage that can be applied to a circuit and cause a current to flow.

The unit employed in the experiments is a junction about ¼ inch in diameter and 1/100 inch thick. To produce enough current to operate a low-power radio, the scientists said, several such units have been connected in series and operated with both atomic and light radiation sources.

A low-power radio was designed for tests with the batteries. It was described in the report as a diode detector followed by three transistor audio amplifiers feeding into an earphone. Because of the low available power from the batteries, the radio used only 10 millionths of a watt in operation, but successfully picked up commercial broadcasts at short range.

The radioactive source employed in the experiments is strontium-90, an atomic fission by-product. When a radioactive source is used, the report said, the junctions are arranged around the material so as to intercept as much as possible of the radiation. In a light battery, it added, the same junctions are arranged to expose as much surface as possible to the light source. An experimental light battery having twelve silicon junctions mounted in a Lucite case has operated the low-power radio in average room light, the scientists said.

The report indicated that some problems remain to be overcome in order to achieve commercially practical atomic and light batteries. One such problem in atomic batteries, the scientists said, has been damage to the crystal wafer by beta particle bombardment. The report stated, however, that such damage ordinarily decreases as the energy of radiation decreases, and that a threshold energy is now believed to exist below which damage will not occur.

Summarizing progress in the development of atomic and light batteries, the scientists stated that prospects for application lie in areas where low power is required, since the potential power range of devices now being studied is less than that of the common dry cell.

Case-less Emergency Lantern

An ingenious utility lantern, the first for poular use ever to utilize a battery which itself is the battery case and with up to four times the life of the ordinary lantern battery, has been designed by the Burgess Battery Company.

The "Radar-Lite" was developed to fill a long-standing need for a lantern with tremendous staying power, yet simple and lightweight enough for women to use as a car or home emergency light, and professionally dependable and powerful enough to be suited for use as industrial standby lighting, auxiliary transportation and marine signal lamps, and for use as reserve disaster and A-bomb shelter emergency equipment.

Measuring only 4x5 inches, the unified battery-and-case is leakproof, and entirely sealed in steel with a reinforced steel ribbed top. It attaches to a removable twin light head with two simple insulated screw caps. To connect the battery and make the circuit, there are no wires to hook up or battery spring contacts to make. The electrical circuit is completed by the metal frame of the light head itself.

An adjustable sealed beam spotlight that can be tilted up or down 135 degrees is the primary light source. A movable red warning light, flashing more than 50 times a minute, which can be operated vertically or horizontically, is mounted to the rear of the spotlight. Both lights are operated with independent silver contact switches.

The power pack consists of two 6-volt lantern batteries wired in parallel to yield the most powerful unit of its type ever developed. Laboratory tests indicate its useful life at 2½ to 4 times that of the conventional single 6-volt lantern battery.

Besides its functions as a universal safety light for motorists and as an all-purpose home lamp for use by women, the new lantern was designed to serve as emergency and standby lighting in industry, hospitals, schools, and other institutions; for portable farm illumina-

Systems Development and The Ramo-Wooldridge Corporation

The Ramo-Wooldridge Corporation (except for the specialized activities of our subsidiary, Pacific Semiconductors, Incorporated) is engaged primarily in developing—and will soon start to manufacture—systems rather than components. For military customers our weapons systems responsibilities are in the fields of guided missiles, fire control, communications, and computers. Our non-military systems activities are in the general area of automation and data-processing.

Emphasis on systems development has consequences that profoundly affect all aspects of an organization. First, it demands an unusual variety of scientific and engineering talent. A single systems development project often requires concurrent solutions of challenging problems in the fields of electronics, aerodynamics, propulsion, random phenomena, structures, and analytic mechanics. In addition, the purely technical aspects of a systems problem are often associated with equally important nontechnical problems of operational, tactical, or human relations character.

Therefore, competent systems development requires that a company contain an unusually large proportion of mature, experienced scientists and engineers who have a wide range of technical understanding and an unusual breadth of judgment. Further, all aspects of company operations must be designed so as to maximize the effectiveness of these key men, not only in the conduct of development work but in the choice of projects as well.

At Ramo-Wooldridge we are engaged in building such a company. Today our staff of professional scientists and engineers comprises 40% of the entire organization. Of these men, 40% possess Ph.D. degrees and another 30% possess M.S. degrees. The average experience of this group, past the B.S. degree, is more than eleven years.

We believe the continuing rapid growth of our professional staff is due, in part, to the desire of scientists and engineers to associate with a large group of their contemporaries possessing a wide variety of specialties and backgrounds. It is also an indication that such professional men feel that the Ramo-Wooldridge approach to systems development is an appropriate one.

We plan to continue to maintain the environmental and organizational conditions that scientists and engineers find conducive to effective systems development. It is on these factors that we base our expectation of considerable further company growth.

POSITIONS ARE AVAILABLE FOR SCIENTISTS AND ENGINEERS IN THESE FIELDS OF CURRENT ACTIVITY:

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Another page for **YOUR BEARING NOTEBOOK**

How to increase gear life in a scraper

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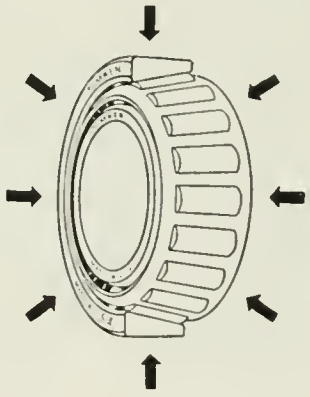
How TIMKEN® bearings hold gear shafts rigid

The line contact between rollers and races of Timken bearings gives shafts rigid support over a wide area. Shaft deflection is minimized. And the tapered design of Timken bearings permits them to be set up with the most desirable amount of end play or preload that gives the best performance.



Want to learn more about bearings or job opportunities?

Some of the engineering problems you'll face after graduation will involve bearing applications. For help in learning more about bearings, write for the 270-page General Information Manual on Timken bearings. And for information about the excellent job opportunities at the Timken Company, write for a copy of "This Is Timken". The Timken Roller Bearing Company, Canton 6, O.

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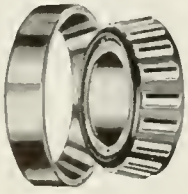

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭
BEARING TAKES RADIAL ◐ AND THRUST —◎— LOADS OR ANY COMBINATION ✳

The Radar-Lite, used for marine signal lamps, has tremendous staying power yet light weight.

tion; for general outdoor, construction, and field use; and for auxiliary highway, rail, marine, and aircraft lighting. It was also conceived as a practical solution to the present need for dependable reserve lighting for homes and offices and as basic civil defense equipment.

Output Increased U.S.S.R.

The Soviet Union increased its industrial output more than eightfold in the quarter-century between 1928 and 1953, and have doubled industrial man-hour productivity since 1928.

In spite of these advances, the volume of Soviet manufacturing and mining in 1954 was only about 35 per cent of that of the United States.

These figures were revealed by a Russian-born expert at the diamond jubilee spring meeting of the American Society of Mechanical Engineers.

The speaker was Demitri Shimkin, social science analyst with the U. S. Department of Commerce, Bureau of the Census. Mr. Shimkin was born in Omsk, Siberia. He was a colonel during World War II, on the general staff, G-2 (intelligence), European theater. He was formerly a lecturer on strategic logistics of the U.S.S.R., at the U. S. Naval War College and the National War College.

Mr. Shimkin said that two fundamental considerations dominate the selection, training and use of physical scientists and engineers in the Soviet Union. The first is the vital role of these specialists in building up Soviet military-economic strength. The other is Communist fear of scientists and engineers as potential subversives.

Summing up, Mr. Shimkin said that "the selection, training and use of physical scientists and engineers in the Soviet Union reveals paradoxical strengths and weaknesses. The application of science on a vast scale is essential to the realization of Soviet ambitions, yet the Communist party dare not trust the scientist and the engineer. The Soviet Union fears the West, yet depends upon its technology."

Given these circumstances, he said, the following conclusions may be advanced:

"1. At the present time, the actual effectiveness of the Soviet Union is scientific innovation and application is far lower than might be indicated by the large number of its physical scientists and engineers, and by the immense Soviet effort, in training and research.

"2. In part, this gap lies in the failure to develop and apply increasingly good basic research. Thus, Soviet science warrants far closer study by the West than Soviet technology indicates.

"3. Beyond this, the Soviets are creating a potential which, given appropriate social changes, might generate a technological revolution.

"4. At the present time, the Soviet utilization of Western technology is limited by Western controls on information flow and exports. Moves toward the modification of these controls should be guided by careful assessment of Soviet technological strengths and weaknesses.

"5. Finally, scientific and technical publications, including trade journals, are a channel of communication behind the Iron Curtain which the Soviet Union simply must keep open. This fact needs wide exploitation both as a means of ensuring a reverse flow of data from the Soviet Union and as a medium for the diffusion of a new hope for a world of peace."

Mr. Shimkin's talk was presented as part of a panel presentation on "The Engineer and the Prospects for Peace."

The ASME meeting here was part of the society's celebration of its 75th anniversary year, and was devoted to the theme, "The Engineer and the World of Government."

Sodium Cooled Reactor

Progress is being made in the solution of problems in the use of sodium as the coolant in nuculear reactors. D. R. Miller and W. E. Cooper, Knolls Atomic Power Laboratory of the General Electric Company, covered some of the design problems of a reactor in which the temperature of the sodium would vary between 600 and 850 degrees F. normally. These temperatures would allow a satisfactory thermal efficiency in the power plant and leave a margin for somewhat higher local temperatures without undue loss of structural strength and ductility.

It was explained that the metal sodium has advantages as a coolant primarily because of its high heat transfer coefficient, several times that of water, and its high boiling point, 1621 deg. F. at atmospheric pressure. It has the additional advantage that its high electrical conductivity, about 20 per cent that of copper, allows efficient pumping with electromagnetic pumps, thus permitting elimination of shaft seals or canned rotor motors. Because of the high heat transfer coefficients, the temperature rise from the main coolant stream to the fuel element surface is small, even with high heat flux densities.

One of the principal difficulties in the reactor design arises from the fact that major loadings are thermally induced, which is rare in other power systems. Sodium's high heat transfer coefficients increase thermal transient stresses in structures in contact with the coolant, since the metal surfaces closely follow the transient temperatures of the sodium. This makes fast temperature transients much more significant with sodium than with water, vapors or gases.

Another disadvantage of sodium is that electrical heaters must be provided to keep the coolant fluid during filling and shutdown. Also sodium becomes highly radioactive and must be contained within a biological shield. Furthermore, to guard against the sodium-water reaction hazard, the system would use multiple barriers between sodium and water, and the intervening spaces would be monitored for leak detection.

In spite of these limitations, extensive experience gained in other types of installations shows that systems utilizing sodium can be made reliable in operation, and with appropriate safety precautions the hazards are no greater than those in many other common industrial systems. The general plan is to assure adequate structural design strength through establishment of conservative stress limits, the recognition of all significant problems, close attention to design details, extensive theoretical and experimental stress analysis, close cooperation among designers, analysts, metallurgists and manufacturing personnel, and the resolution of borderline cases individually after consideration of all factors, including schedules and consequences of mechanical failures.

The authors stated that they are not satisfied with present design bases for stress limitation, but are striving for improvement which must be accompanied by increased knowledge in the fields of metallurgy and stress analysis. The fatigue behavior metals subjected to strain cycling is being studied further under severe conditions, for example. Further fundamental investigation, theoretical and experimental, of many additional problems is necessary. The aim of improved design bases is to provide more definite safety factors and a minimum of restraint on design because of ignorance of stresses and their effects on structures.

PHOTOGRAPHY AT WORK—No. 15 in a Kodak series

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Counting people comes as easily for photography as counting phone calls, metal rods or tons of coal. It is one of the many ways it is serving all kinds of business and industry. In small businesses and large it is helping to save time, cut costs, reduce error, design new products and improve production.

Graduates in the physical sciences and in engineering find photography an increasingly valuable tool in their new occupations. Its expanding use has also created many challenging opportunities at Kodak, especially in the development of large-scale chemical processes and the design of complex precision mechanical-electronic equipment. Whether you are a recent graduate or a qualified returning serviceman, if you are interested in these opportunities, write to Business & Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.

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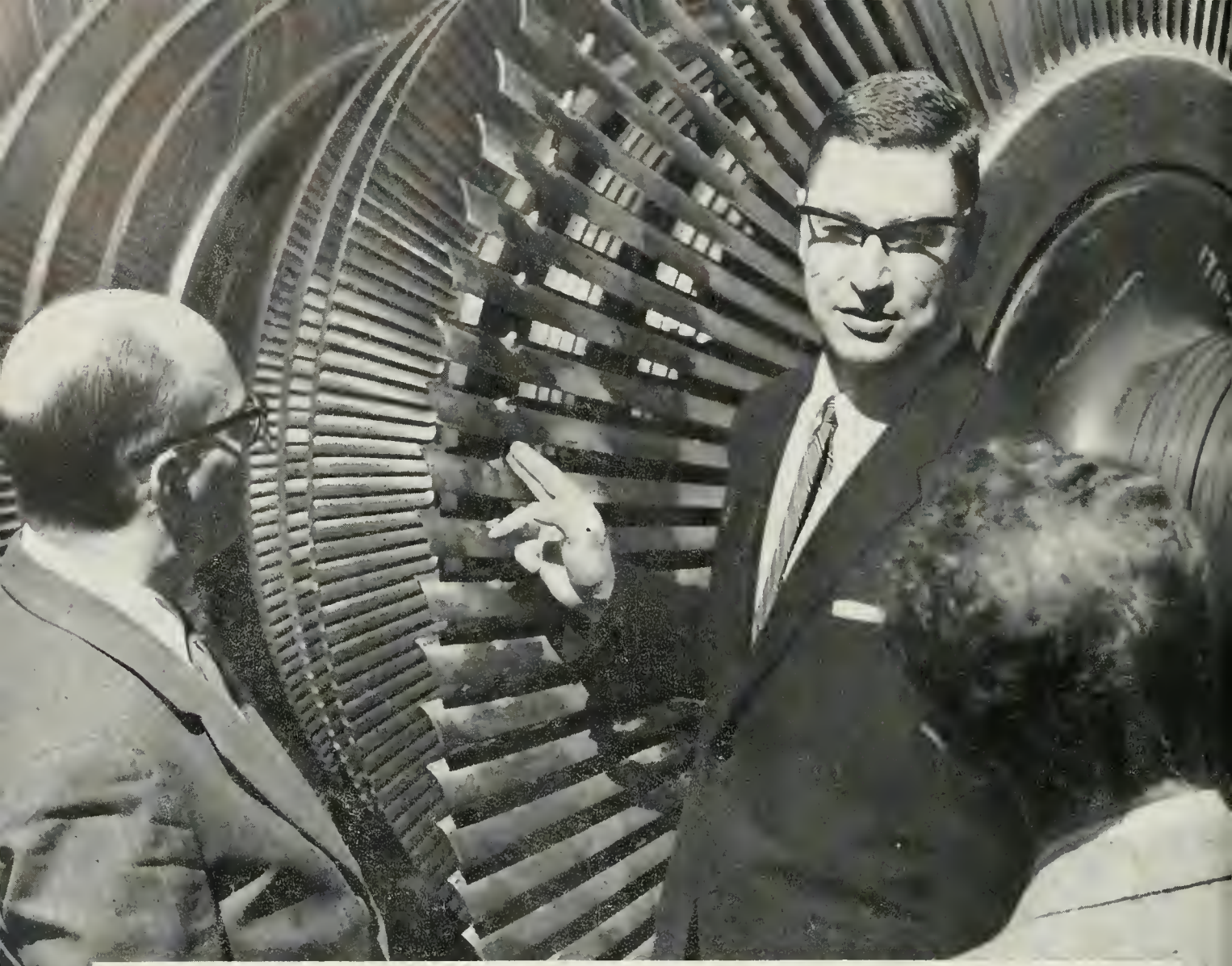

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*ILLUSTRATION: *Sales Engineer and customers discuss turbine rotar construction. Glasses are factory safety measure.*

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